Concrete

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Greater Strength Per Dollar

Why Concrete Yielding 3000 and 4000 lbs. per sq. in. Is More Economical Than 2000 lb. Concrete

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THE "Handbook of Reinforced Concrete Building Design" published by the Portland Cement Association and reprinting a paper (published in *Proceedings,* American Concrete Institute, Vol. 24, 1928) entitled "Design and Cost Data for the 1928 Joint Standard Building Code," by Arthur R. Lord, B.S., M.S., C.E., should be in the hands of every progressive structural engineer and designer.

The point of particular interest in connection with the subject considered in this article is that Mr. Lord shows average savings of $0.05 per total square footage of floor area by the use of 3000-lb. concrete as a basis of design instead of the customary 2000-lb. concrete. In such cases as that of theaters, where the dead-load of balconies in 2000-lb. concrete would be 8 to 10 times the live-load, it can be readily seen that saving of $0.05 to $0.25 per total square footage of floor area would be possible.

It is obvious, of course, that the use of higher strength concrete permits of lighter design for the same live-loads and this reduction of dead-load correspondingly reduces the cost of provision for carrying the dead-load. Another and not well known reason for this economy is the fact that concrete of 3000-4000 lb. strength can be made more economically in proportion to its strength than the usual basis of design, 2000-lb. concrete. In other words, it has more strength in proportion to its cost.

Advantages of High Strength Concrete

Recent developments make it practicable to produce 4000-lb. concrete with greater exactness and uniformity than 2000-lb. concrete has been produced heretofore, and 3000-4000 lb. concrete, so produced, has the following advantage over 2000-lb. concrete.

(1) Greater strength in proportion to cost;
(2) Better workability, flowability and cohesion in the fresh mix and economy in placing;
(3) Optimum conditions of strength, density, impermeability and elasticity;
(4) Optimum conditions of shrinkage in setting and plastic flow under stress;
(5) Greater durability to wear and exposure;
(6) A greater margin of safety; and
(7) Resulting economy.

The following tables, comprising analyses of data published by the Portland Cement Association under the title "Design and Control of Concrete Mixtures" (January, 1927), show that concrete of greatest economy is that having

(a) Strength of 3000 to 4000-lb. per sq. in.;
(b) Maximum usable size of aggregate;
(c) Minimum usable water-cement ratio; and
(d) Skilled control of production.

Our experience shows that these data are substantially correct under average conditions with normal standard portland cement and aggregate of standard quality. They are presented as supplementary cost data for the purpose of comparative design.

Cost of cement is assumed as $3.00 per barrel and aggregate at $2.00 per ton delivered to the mixer.

Explanation of Tables 1 to 4 (appearing on page 48)

The tables show (for concretes of 1500 to 2000, 2500, 3000, 3500, and 4000 lbs. per sq. in., respectively at 28 days):

(1) The true mix;
(2) Sacks of cement per cu. yd. of concrete;
(3) Cost of materials per cu. yd. of concrete; and
(4) Compressive strength in proportion to cost of materials for both
  (A) Skilled control; and
  (B) Ordinary control; and for ¾ in., 1 in., 1½ in., 2 in., and 3 in. (square hole) maximum size of aggregate.

Each table is for a particular consistency of mix as indicated by the standard slump test.

Example

Assuming 1 in. maximum size of aggregate and 6 in. to 7 in. slump for 2000 and 3500 lb. concrete for skilled and ordinary control, we find, in Table 5, the following comparative figures for a cu. yd. of concrete:

Table 5.—Comparison of Skilled and Ordinary Control

	Skilled	Ordinary	Skilled	Ordinary
Strength at 28 days	2000	2000	3500	3500
Dry-rodded aggregate per sk.	5.10	4.00	2.65	1.95
Sks. per cu. yd of concrete	5.10	6.30	8.70	11.20
Cost of materials	$7.09	7.58	9.29	10.60
Pounds strength per dollar	282	264	377	330
Saving by skilled control	$0.49	———	$1.31	———

The relative costs of skilled and ordinary control based on our experience are as shown in Table 6:

Table 6.—Relative Costs of Skilled and Ordinary Control

Cubic Yards of Concrete in project	Skilled Control Cost per cu. yd. of Concrete	Ordinary Control Cost per cu. yd. of Concrete
1,000	$0.43	$0.21
2,000	0.365	0.155
3,000	0.33	0.13
4,000	0.305	0.115
5,000	0.29	0.105
6,000	0.275	0.10
7,000	0.265	0.095
9,000	0.25	0.85
10,000	0.24	0.08
12,000	0.23	0.075
14,000	0.22	0.07
17,000	0.21	0.065
20,000	0.20	0.06
25,000	0.19	0.055
30,000	0.18	0.05
40,000	0.17	0.045
50,000	0.16	0.04
500,000	0.09	0.015
1,000,000	0.075	0.011

Assuming a 10,000 cubic yard project, the excess cost of skilled control of the concrete production is $0.24 minus $0.08 or $0.16, as shown in Table 6. This excess cost is due to the fact that one man-hour of skilled control is required for every 10 cubic yards of concrete as compared with one man-hour of ordinary control for every 23 cubic yards. By the more efficient combination of materials, however, the net saving by skilled control, with conditions as given for Table 5, would be 10,000 ($0.49 — $0.16) = $3,300 for 2000-lb. concrete, and 10,000 ($1.31 — $0.16) = $11,500 for 3500-lb. concrete.

Tables 1, 2, 3, 4, and 6 provide the structural designer with data for the determination of comparative costs of designs as affected by the strength of concrete used and by the character of concrete production control.

Economy in structural design depends largely upon the absolute concrete mixture (of essential workability and usable size) having the greatest strength in proportion to cost of materials and upon the use of that strength as the basis of design.

That concrete mixture having the greatest strengths in proportion to cost, for the particular workability and usable size of aggregate, has also the optimum of durability, density, impermeability, uniformity, elasticity, and of minimum shrinkage, expansion, and contraction (by moisture variation) and plastic flow under stress.

The concrete of greatest strength in proportion to cost, and likewise economy, depends upon

Cement quality and content;

Water-cement ratio;

Quality, shape, maximum and minimum size and coarseness modulus of the mixed aggregate;

Uniformity and character of grading of the mixed aggregate;

Cement to voids in the fine and in the mixed aggregate;

Sand and mortar to voids in the coarse aggregate;

Accuracy of measurement of aggregates, cement and water;

Mixing time;

Efficiency of storage, measuring, mixing, transporting, placing and curing equipment;

Moisture and temperature of curing;

Workmanship in measurement, mixing, placing and curing;

Practical and scientific manufacturing control on the job; and

Practical and scientific basis specifications making essential provisions of the foregoing so that the honest and competent contractor, with equipment for quality production, cannot be underbid by the contractor who makes his profit on the cement he does not use.

Considering the safety of higher strength concrete, it should be observed that, for a given safety factor, the margin of excess strength is proportional to the unit strength of the concrete. For a safety factor of four in the cases of 4000-lb. and 2000 lb. concrete, for example, the margin of safety is 3000 and 1500 lb. per sq. in. respectively.

A. C. I. Reorganizes Committees

Following the decisions made at the business session of the American Concrete Institute convention at Detroit, the Board of Direction of the Institute approved the Advisory Committee's plan for committee reorganization. All former committees were discontinued and 37 new committees were set up.

Under the new plan, committees whose duties are related to the organization and administration of the general work of the Institute will be appointed by the Board of Direction and will report to the Board. All other committees will be organized into nine departments with a chairman and two or more co-chairmen representing each department.

The administrative committees will consists of (1) the Advisory Committee, (2) the Program Committee, (3) the Publications Committee and (4) the Medals Award Committee.

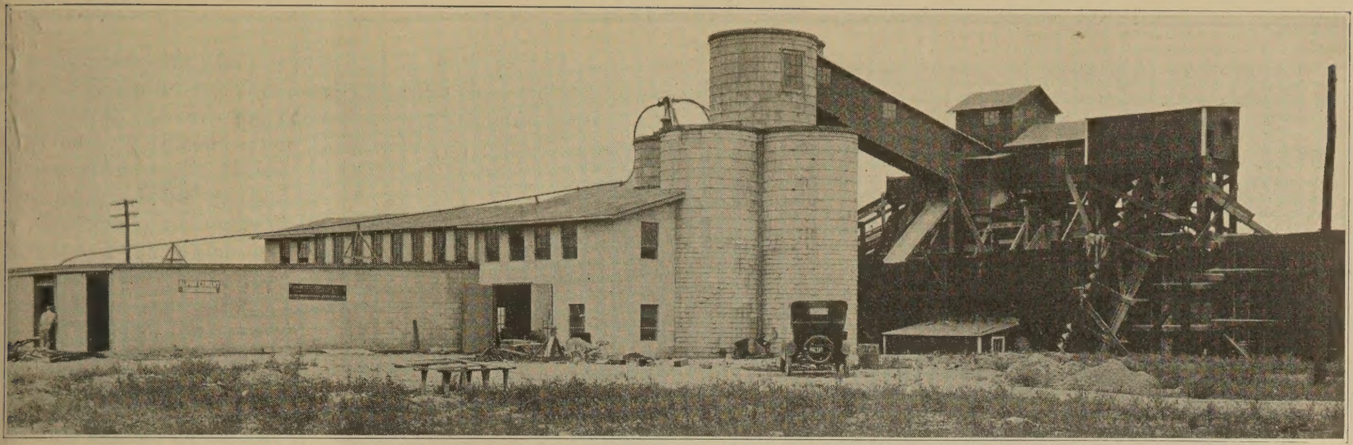
The technical work of the Institute will be grouped into nine departments. Each department will be assigned a master number and all subsidiary committees and working units will take numbers in the proper departmental series. The nine departments with their key numbers will be as follows: 100, Department of Research; 200, Department of Materials; 300, Department of Engineering Design; 400, Department of Architectural Design; 500, Department of Specification; 600, Department of Field Construction; 700, Department of Shop Manufacture; 800, Department of Use Requirements; 900, Department of Joint Efforts.

The new committee organization will require a greater number of workers than under the previous organization and it is expected that a wider scope of activities can be undertaken.

Mt. Vernon Memorial Parkway to Have 200-Ft. Pathway

Construction is to begin shortly on the Mt. Vernon Memorial Highway, between Washington and Mt. Vernon, Va. One of its features will be an adequate right-of-way. The Memorial Highway will be placed on a strip of land 200 ft. wide. At first, a 40-ft. pavement will be constructed, with additional hard surfacing to be laid later when traffic demands it. The roadway will be more than 15 miles long.

Grade intersections with railways and all other heavily traveled roads will be entirely avoided by means of overpasses and under-passes. Further insurance against accidents will be given by the establishment of well-kept dirt shoulders extending 10 ft. on either side of the pavement.



General view of the plant, showing the housed-in conveyors that bring the aggregate to the storage bins

Everything in Concrete

The Department Store Idea Applied to the Concrete Field—Permanent Products, Inc., of Columbus, Ohio, Supplies Most Types of Concrete Products as Well as Centrally Mixed Concrete for All Uses

WHATEVER you may want in concrete—whether it is so many cubic yards of 1:2:4 concrete; or so many cubic yards of 2500-lb. concrete; or concrete block, pipe, fence posts, crossing slabs, or what not, just call up the Permanent Concrete Products, Inc., at Columbus, Ohio, and the trucks will deliver the material ordered at the job. What is more, the quality of the product will be *guaranteed.*

Here is an unusual development in the concrete field—a veritable "department store" where all types of concrete products and all classes of concrete itself may be purchased "over the counter." And, like in many other fields, the reputation of this "store" is based on quality goods and prompt service. Of course, there is another element that enters into the scheme. The "goods" handled are also manufactured by the merchant. This is an advantage for it enables the seller to control the quality of his products absolutely and it eliminates the middleman.

It has been suggested that a development similar to this one may ultimately become the rule and that concrete products manufacturers may look to an establishment of this sort as an indication of the ultimate development in their industry.

Recently a man of many years of experience in the concrete industry said that a new branch of the concrete industry is developing. He said that there will be concrete building material dealers—concerns that will make and sell a complete line of concrete materials, including all types of concrete products and centrally mixed concrete.

Perhaps such "concrete stores" will evolve out of the present block plants. Their success will be based on the same principles that govern other manufacturing and merchandising lines.

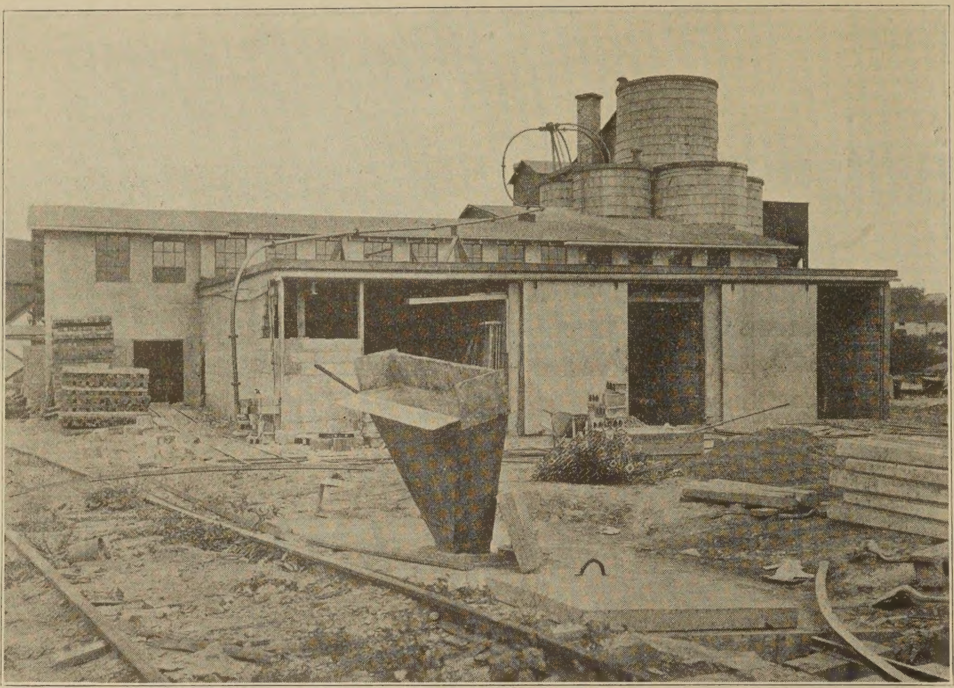
Here is an account of one such development. In it are some helpful suggestions.

How the Plant Started

The Permanent Concrete Products, Inc., is a subsidiary of the American Aggregates Corp., one of the country's largest producers of sand and gravel, with headquarters at Greenville, Ohio.

The products manufacturing and central mixing plant, which operates independently of the mother organization as the Permanent Concrete Products, Inc., is largely the result of the vision and work of George E. Nagel, manager of the plant. Mr. Nagel has been associated with the American Aggregates Corp. for a number of years, prior to which he operated a concrete products plant in Greenville, Ohio. This plant was purchased by the American Aggregates Corp. and is now also being operated by the Permanent Concrete Products, Inc., as well as a plant at Kalamazoo, Mich. C. E. Haines, also an experienced concrete products manufacturer, is assistant manager.

The Columbus plant, described in this article, is the third plant established by this company and is the result of a desire to expand the concrete products end of



Showing the hopper in place, ready for unloading bulk cement from cars into the Fuller-Kinyon conveying system. Cement is transported through the pipe into the storage bins over the plant

the business.

Make a Wide Variety of Products

Approximately 10 years ago the Permanent Concrete Products, Inc., started the manufacture of concrete fence posts, mile posts, sign posts, crossing slabs, rail rests, pipe carrier foundations, cribbing units, etc., at the Greenville plant. The railroads were large buyers of these products and it was here that the foundation for confidence in the products was laid. Every article sold was guaranteed absolutely for a lifetime. If it did not live up to the guarantee another article was sent to replace it. It is interesting to note that in ten years of concrete post manufacture not more than one hundred posts have been returned for replacement.

It is with a reputation built on such performance that the Columbus plant started to serve its territory.

The Central Mixing Plant

The central mixing plant department of the Permanent Concrete Products, Inc., at Columbus, started operation in July, 1928. Its design is based on securing absolute concrete control most effectively.

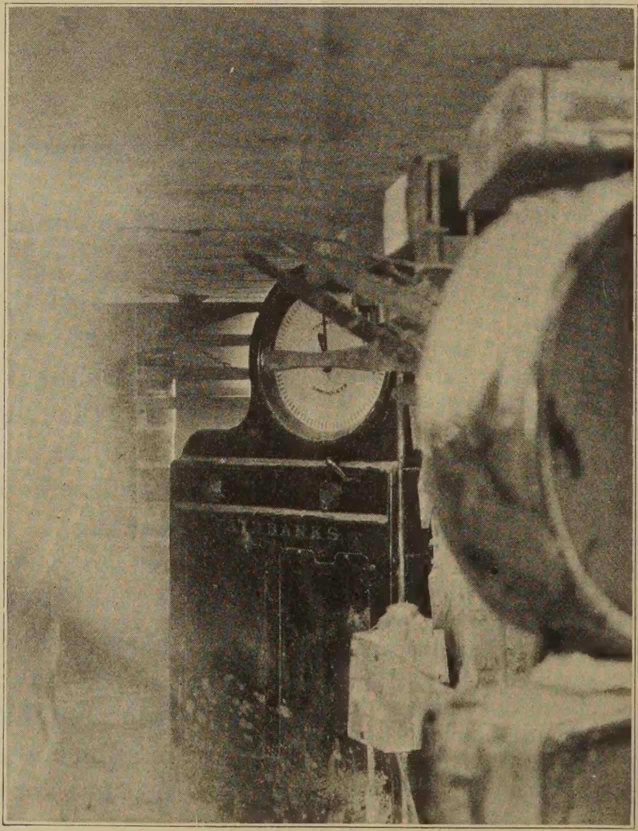
The mixing plant, as well as the other departments, is located on a five-acre tract adjacent to a large sand and gravel deposit owned and operated by the holding company, the American Aggregates Corp. Sand and gravel are, therefore, conveyed directly from the American Aggregates Corp. plant to the storage silos by rail to a discharge hopper, and thence by means of a belt conveyor.

Materials storage is provided by six concrete stave silos, four of which are 12 ft. in diameter and 30 ft. high. They are used for storing sand and gravel. The two remaining silos are reserved for cement and are 10 ft. in diameter by 20 ft. high, having a capacity of two carloads each of cement.

Once the materials are in the storage silos, they are handled entirely by gravity through the measuring hoppers and the mixer. All the materials are proportioned by weight, including the cement. Sand and gravel drop from the silos through batching hoppers onto a Fairbanks-Morse scale equipped with an 8,000-lb. dial. The scales discharge into a 2-yd. Rex mixer.

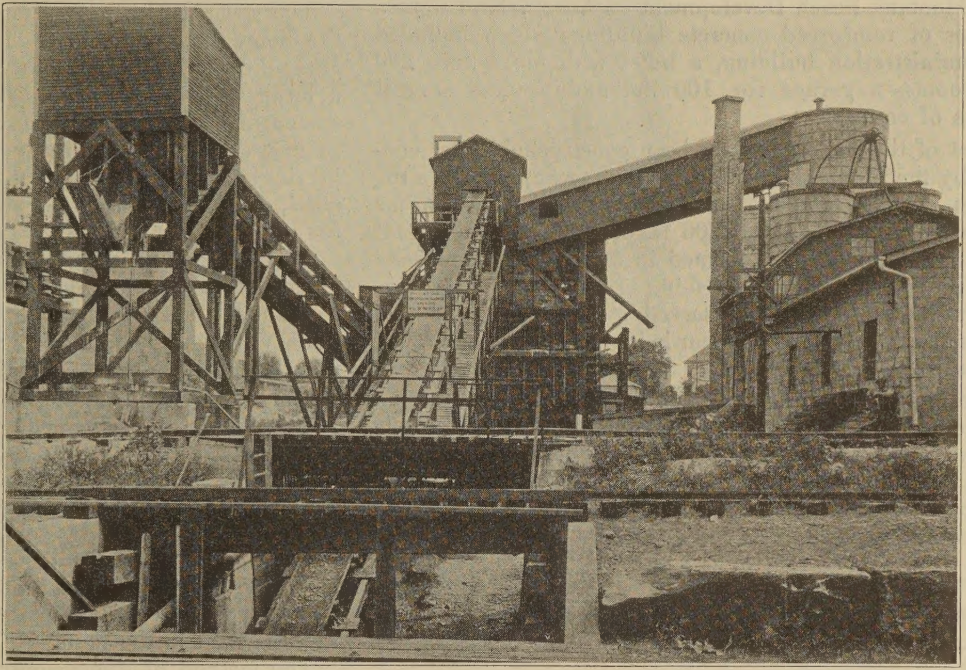
Cement Received in Bulk

The cement used in both the central mixing plant and



The scales used for weighing materials, including sand, gravel and cement in the products plant is received in bulk in railroad box cars. A Fuller-Kinyon pump, located in a pit alongside the track, conveys the cement through a 3-in. pipe from the cars to storage. The Fuller-Kinyon pump is located underground and cement is shoveled directly into a hopper which feeds the pump.

Another Fairbanks-Morse scale weighs the cement required, from which it is conveyed to the mixer for delivery to the job or to the products plant. Graham agitator trucks are used to deliver the ready-mixed concrete. These trucks are equipped with revolving blades, which turn slowly en route to the job.



The conveying system for sand and gravel

The Products Plant

Though the principal products manufactured in the products department of the plant are railroad crossing slabs, fence and mail box posts, etc., equipment has been purchased for the manufacture of block, roofing tile and pipe. The products department occupies the greatest portion of the space in the building that houses the entire plant.

Buckets operating on an overhead tramrail system convey the concrete from the mixer to the gang molds in which the posts, slabs, etc., are cast. These molds are placed over vibrators, designed and made by the Permanent Products, Inc., which compact the concrete into the forms evenly.

By means of the overhead monorail system and electric Yale & Towne hoists, the molds containing the products are picked up and conveyed to the curing rooms. They are cured in the kilns over night, after which they are sprayed in the yard for ten days. After 28 days' total curing they are ready for shipment.

By the vibrating system all air is eliminated from the product, resulting in greater density. Also the appearance is improved. By this method government mail box posts are cast and in testing for tensile strength, 50 per cent more strength is secured than necessary. In over 4000 posts already shipped on a present order, not one complaint has been received.

Railway crossing slabs are made 16¾ in. by 6 ft. 6 in., bound around the top or wearing edge with channel and reinforced with 14 square twist bars longitudinally and 10 transversely. During 1928, about 1500 crossings throughout the Central West were relaid with these concrete slabs. The improvement is noticeable when riding over the crossing, even though one is not aware of the cause. By the use of slabs, the railroads are finding them easily removable when ballasting or laying new ties.

All railroad and government products are sold through sales agents, the Prendergast Company, of Marion, Ohio. All commercial products, such as fence posts, arbor posts, roof tile, building tile, ready mixed concrete, etc., are sold direct to contractors and the ultimate consumer.

Speculation Decreases March Building Volume

The backlash from the diversion of finances to speculative purposes showed its first definitely injurious effects on the construction industry during March, according to statistics just compiled by the Associated General Contractors of America.

The figures, representing current construction operations of all types, based on shipments of construction materials, show a decrease of 5 per cent in volume of construction performed during March as compared with February. This is a reversal of the usual seasonal trend.

Contract awards in 27 states during February declined 15 per cent from those of January and were 26 per cent less than in February last year. Thus for the two recorded months this year contract awards show a decline of 15 per cent over the same period last year.

That the basic cause of this decline has been the rapidly fluctuating money market with its periodical high money rates is indicated by reports of increased contemplated work compiled by F. W. Dodge Corporation. This work has evidently had no opportunity to mature in sufficient quantity to maintain activity at past levels.

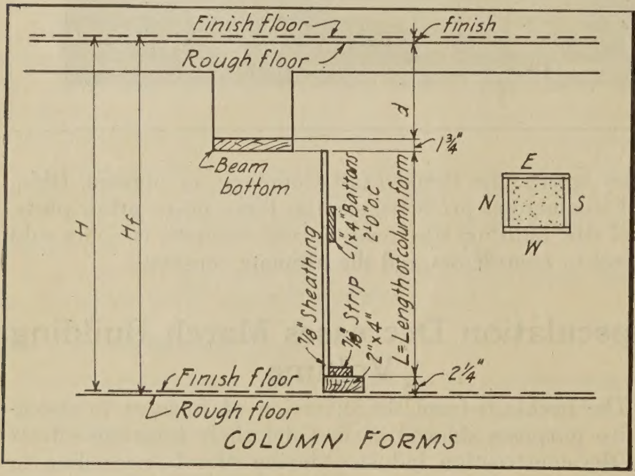
Scheduling Form Work

Method of Detailing, Standardizing and Fabricating Form Work on a Large Eastern Job—Savings Effected Through Duplication—Forms Made Up in Single Panels in Contractor's Shop and Assembled When Required

AMONG the improvements undertaken as a part of the Montauk Beach Development on Long Island were a number of reinforced concrete buildings which included an administration building, a hotel with more than 200 guestrooms, a garage for 100 automobiles and several groups of cottages.

Most of the buildings have been constructed under contract by the Montauk-Struck Company, who, used for the frames of the cottages, for concrete forms and similar purposes, more than 1,000,000 ft. of dressed lumber that was cut and much of it framed in a field shop equipped with 2 electrically-driven 16-in. cross-cut and rip-saws with swinging tables that served a large force of carpenters, as many as 40 of them being sometimes employed on the forms.

The Montauk Inn has one 195-ft. and one 225 ft. wing connected by a 132-ft. section and is a reinforced concrete structure with concrete floors. The 70 by 40-ft. $220,000 administration building is a 7-story reinforced concrete structure 100 ft. high of the modern office building type of construction with crenelated parapet and towers.



$$L = H - 4'' - d$$

Outsides of corner columns are $d + 1\frac{3}{4}''$ *longer or*

$$L_0 = H - 2\frac{1}{4}''$$

For rough lower surfaces (footings) forms will be L-finish when using H_f *or*

$$L = (H_f - 4'' - \text{finish} - d)$$

The widths of two parallel form sides are always the same, but one pair is 1¾" longer than the column faces they cover, in order to lap over the edges of the other pair.

Column sides are given the column number and the letter N, S, E or W depending upon whether the column form side is for the north, south, east or west face of the column. For instance, C101N, C101S, C101E, C101W.

BEAM BOTTOMS

Length is from face to face of columns so as to rest on top of column forms.

Width is lumber width of dressed lumber for the dimension given for the width of the beam.

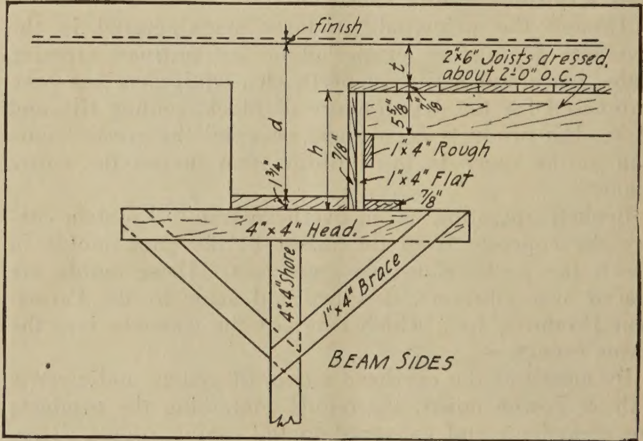
Thickness = 2" dressed lumber (i. e., about 1¾").

Form Work Standardized

The great quantity of reinforced concrete required for the floors and columns of the hotel, servants' quarters, garage, office building, and other large structures involved a large amount of form work which was simplified and standardized by the contractor's engineer, A. C. Hillberg, so that all forms were made up in the contractor's shop in single panels properly marked and stored and very quickly and easily selected and assembled when required for use.

This system insured great accuracy and rapidity, provided the largest possible number of duplicate pieces, and furnished a simple method by which the materials and units were sketched, billed, and listed so as to prevent mistakes, waste or delay. All of the work was done on schedule time and the carpenters were furnished with very simple, separate sketches or diagrams which enabled them to prepare the different panels for the forms without the necessity of studying blue prints or figuring dimensions. This increased the rapidity, accuracy and economy of the work by completing the greatest possible proportion of it in the office where it was checked and approved before being issued, thus confining any possible errors and their correction to the office, where the cost is far less than in the field.

The method of dimensioning the forms and preparing the working bills is illustrated by the beam and column data for the administration building, in which there was comparatively little complication and the work was regular and with only a moderate number of necessary variations.



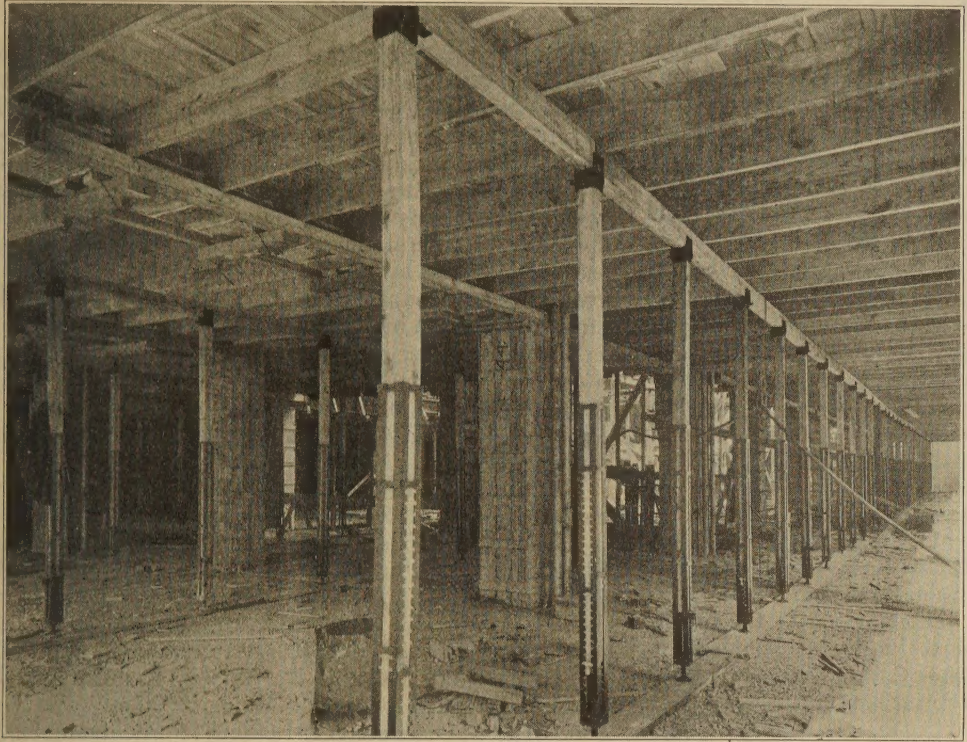
Height of beam side:

$$h = d + 1\frac{3}{4}'' - t - \frac{7}{8}''$$

$$h = d + \frac{7}{8}'' - t$$

Length = Dist. concrete faces of columns or
Dist. — ⅞" concrete faces between column and wall or
Dist. — 1¾" concrete faces between beams.
Battens 1x4 Flat for h up to 20"
2x4 Flat for h 20" to 30"
2x4 on edge for h > 30".
Mark B12AN or B12AS, being for both faces of B12A.

The governing dimensions for the floor panels in four stories of this building were properly marked on a single plan serving for the second, third, fourth and fifth floors of the building. As the thickness of the columns diminished, the over-all lengths of the beams connecting them increased upwards and were recorded on successive lines on the blue print. All columns were identified by serial numbers and the connecting beams by numerals and letters.



Type of adjustable telescopic steel and wood shores used to support concrete beam forms in servants' quarters and garage

Column Forms

The column forms were vertical boxes with rectangular cross sections, on each side of which was a single separate panel of ⅞-in. square-edge sheeting nailed to transverse 4- by 1-in. battens. All of the lumber was dressed on all sides and dimensions were given to correspond with the net width and thickness. The height of the column form was equal to the distance between the bottom of the beam forms and the top of the finished floor and was determined by the subtraction of beam and material thicknesses from the center-to-center distances between floors.

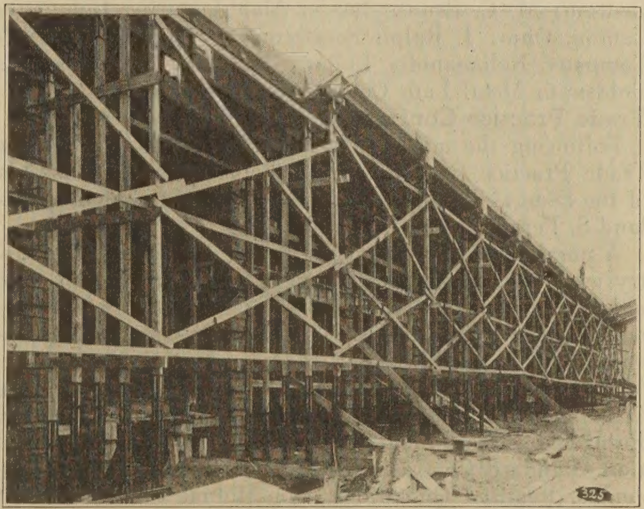
All of these constant dimensions were marked on a diagram from which a formula was derived giving the column length in terms of the floor height, beam depth and a given distance, making it very easy to take these values by inspection and make up the carpenter sheets for the column panels.

The widths of the opposite sides of a column form were always equal, but on two sides were 1¾ in. greater than on the other two sides so as to lap over their edges. The column panels were marked with the column number and the letter N, S, E or W to indicate whether that panel was on the north, south, east or west side of the column.

Beam Forms

The lengths of the beam form bottoms were made equal to the net distances between the concrete faces of the columns thus giving them a bearing on the upper end of the column forms. Their width was a multiple of standard dressed lumber pieces, and the thickness was about 1¾ in., corresponding to the thickness of a 2-in. dressed plank.

The ⅞-in. thick beam form side panels were made with one or more horizontal boards connected by outside vertical battens to which, if necessary, there was nailed a longitudinal center strip to give bearing for the ends of the joists supporting the floor slab forms. The width of each of the side form panels was expressed in terms of the beam depth and the thickness of the floor slab bottom forms. All column forms were marked C, together with the other identifying letters and figures and the form beam panels were marked B together with other identifying letters and numbers.



Adjustable telescopic shores supporting concrete floor forms

Fifth Annual Meeting of Reinforcing Steel Institute Held at Asheville

The attendance at the Fifth Annual Meeting of the Concrete Reinforcing Steel Institute, held at Asheville, North Carolina, April 15th-17th, broke all previous records and has been referred to as one of the most successful meetings which the Institute has held.

It was followed on April 18th by a Trade Practice Conference, held under the auspices of the Federal Trade Commission—presided over by Commissioner Garland S. Ferguson, Jr.

C. Louis Meyer, (president of the Concrete Engineering Company, Omaha) was elected president of the Institute; O. W. Irwin (vice-president of the Truscon Steel Company, Youngstown) was elected vice-president; Hugh J. Baker (president of Hugh J. Baker & Company, Indianapolis) was re-elected as treasurer; Charles M. Gunn (president of Gunn, Carle & Company, San Francisco) was re-elected to the Board as representing the Pacific Coast; George E. Routh, Jr. (vice-president, Kalman Steel Company, Chicago) was re-elected as a director; and Louis J. Lind (president of the Carlem Engineering Company, Pittsburgh) was also elected as a director. M. A. Beeman was re-appointed secretary, and R. W. Johnson was re-appointed engineer for the forthcoming year.

Speakers

The following addresses were delivered: "A 'Stop Order,'" by H. G. Moock; "Current Events," by O. W. Irwin; "Engineering Costs," by W. S. Thomson; "New Markets for Reinforcing Steel," by W. D. M. Allan; "New Libraries for Old," by James Schermerhorn.

Reports were presented by the chairmen of the following committees: Mill Support, Publicity, Membership, Engineering Practice, Building Code, Grade of Steel, Standard Practice and Credit Information.

New Department of Institute

At the Wednesday evening session the members voted to set up a new department of the Institute to deal with concrete ribbed floor construction to be operated, during the first year, by the following committee: Chairman, C. Louis Meyer, Concrete Engineering Company, Omaha, Nebraska; Louis Aronstam, Southern G-F Company, Atlanta, Georgia; M. C. Brown, Berger Manufacturing Company, Canton, Ohio; J. Ralph Fenstermaker, Hugh J. Baker & Company, Indianapolis, Indiana, and Wm. M. Goldsmith, Goldsmith Metal Lath Company, Cincinnati, Ohio.

Trade Practice Conference

Following the adjournment of the Institute meeting a Trade Practice Conference was held under the auspices of the Federal Trade Commission with Commissioner Garland S. Ferguson, Jr., in the chair.

A number of rules covering the reinforcing steel industry were proposed and after an extended discussion were adopted by the conference and were submitted to the Federal Trade Commission for its consideration. These rules comprised such subjects as: Inducing Breach of Contract, Misbranding or Misrepresentation, Secret Rebates, Price Discrimination, Illusory Contracts, Commercial Bribery, Published Prices, Single Bid Policy, Dumping, Arbitration, Standard Contracts, Departures from Terms of Discounts, Itemized Quotations, Non-Mutual Contracts, Cost Accounting and Indefinite Contracts.

The Trade Practice Conference created an executive committee of seven members as a continuing organization to act for the progressive elimination of unfair and uneconomic practices in the reinforcing steel fabricating and distributing industry. This executive committee consists of the following: C. Louis Meyer, Concrete Engineering Company, Omaha; O. W. Irwin, Truscon Steel Company, Youngstown; W. H. Pouch, Concrete Steel Company, New York City; George E. Routh, Jr., Kalman Steel Company, Chicago; R. J. Southwell, Wickwire-Spencer Steel Company, New York City; A. E. Roeth, Inland Steel Company, Chicago, and W. W. Scott, Jr., Laclede Steel Company, St. Louis.

States Receive Federal-Aid Pavement Money

Secretary of Agriculture Jardine recently apportioned $73,125,000 to the states as federal aid in road construction for the fiscal year which begins on July 1 next. This apportionment has been authorized by Congress for continuing the federal-aid program, and the funds will be expended according to the same provisions which have governed past expenditures. In general the states pay half the cost of federal-aid construction. Federal-aid funds are administered by the Bureau of Public Roads and are available only for routes on the federal-aid system which includes the main highways of the nation.

During the last fiscal year improvements were completed on 8,184 miles of federal-aid road which had not previously been improved with federal assistance, and advanced stages of improvement were completed on 2,014 miles.

The apportionment of $73,125,000 for the fiscal year ending June 30, 1930, is as follows:

Alabama, $1,554,221; Arizona, $1,061,111; Arkansas, $1,284,382; California, $2,495,345; Colorado, $1,388,755; Connecticut, $477,110; Delaware, $365,625; Florida, $909,235; Georgia, $1,980,443; Hawaii, $365,625; Idaho, $933,902; Illinois, $3,118,949; Indiana, $1,917,036; Iowa, $2,020,861; Kansas, $2,058,305; Kentucky, $1,417,634; Louisiana, $1,026,696; Maine, $678,501; Maryland, $633,615; Massachusetts, $1,090,077; Michigan, $2,204,966; Minnesota, $2,108,104; Mississippi, $1,311,391; Missouri, $2,392,021; Montana, $1,554,060; Nebraska, $1,586,299; Nevada, $960,375; New Hampshire, $365,625; New Jersey, $937,434; New Mexico, $1,189,085; New York, $3,617,748; North Carolina, $1,716,919; North Dakota, $1,197,586; Ohio, $2,754,446; Oklahoma, $1,748,857; Oregon, $1,191,989; Pennsylvania, $3,325,854; Rhode Island, $365,625; South Carolina, $1,061,447; South Dakota, $1,229,282; Tennessee, $1,609,662; Texas, $4,531,162; Utah, $848,592; Vermont, $365,625; Virginia, $1,433,405; Washington, $1,149,489; West Virginia, $796,408; Wisconsin, $1,854,580, and Wyoming, $939,536.

Testing Concrete

The Leeds branch of the Institution of Structural Engineers recently reviewed and discussed several aspects of the bearing of laboratory tests on concrete construction.

The Science Committee of the Institution is considering the advisability of drawing up a specification for a standard laboratory concrete for reference purposes. The specifications, if adopted, would need to cover materials, and states of coarse and fine aggregates, cement, water, curing, and temperature conditions. There appeared to be a fairly general concensus of opinion among those present that such a standard would serve no practical purpose. On a job a suitable strength is specified for the particular work, and no better strength is expected. Adequate supervision by the resident engineer or clerk of works will insure no worse. A laboratory standard made under controlled conditions has little bearing on mix made on the job.

Reinforced Concrete Caps for Timber Columns

A Specialty Now Overlooked by Contractors and Products Manufacturers—Detailed Instructions on Manufacture and Use

CONCRETE contractors and products manufacturers whose market territory includes localities where heavy timber construction is among the types commonly employed may have overlooked a profitable sideline in the form of reinforced concrete caps for timber columns.

A heavily reinforced concrete cap intended for such use was devised so long ago as 1920 by S. H. Ingberg, of the United States Bureau of Standards, for use in a series of fire and water tests of timber columns under full load. Little publicity was given to the cap at the time of its use for the purpose just stated.

The reinforced concrete cap designed by Mr. Ingberg is shown in the detailed drawing in this article. He had the cap patented, but assigned the patent to the public.

Greater Fire Resistance

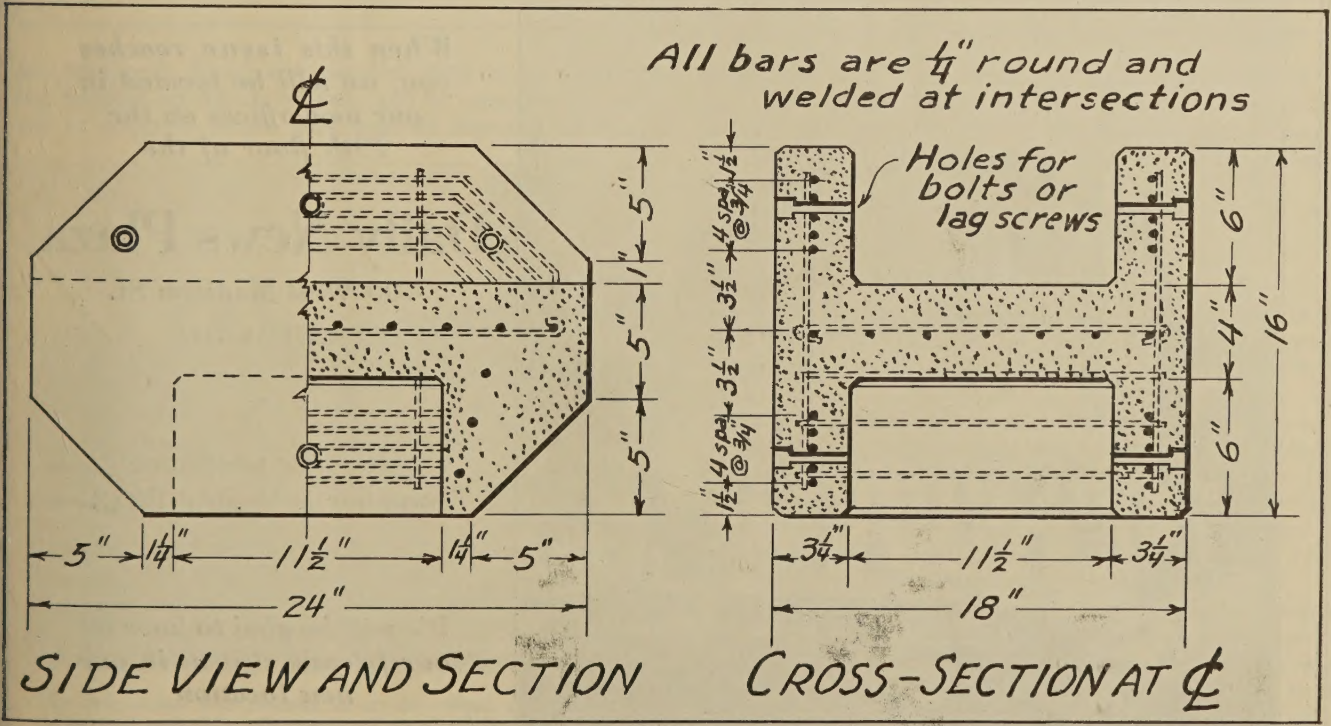
This reinforced concrete cap had its origin in the desire to obtain a cap that would develop the full fire-resistance of heavy timber columns. During 1917 and 1918 the Underwriters' Laboratories conducted a series of fire and water tests on 106 full-size building columns of various materials, with a full load imposed on the columns during the test. These tests were sponsored by the National Board of Fire Underwriters, the United States Bureau of Standards and the Associated Factory Mutual Fire Insurance Companies.

The heavy timber columns included in the Underwriters' Laboratories series withstood the test for only 25 to 30 minutes. The failures, however, were caused in all cases by softening of the wood under the cap bearing. The caps, some of which were of cast iron and some of steel, readily conducted the heat into the wood. The softening of the wood under the caps resulted in large compressive deformation of the wood at this point, fracturing the cast iron caps and causing the steel plate caps to slip laterally, so that the column could not support its load. In each case the column shafts had considerable reserve strength remaining at the time of the failure at the caps.

The condition just described suggested the need for caps of greater fire-resistive properties. Accordingly, at the initiative of a materials association, arrangements were made for a supplemental series of tests on timber columns fitted with the Ingberg reinforced concrete cap, the details of which are shown in our illustration.

Six tests were made on 12-in. by 12-in. timber columns, about 11 ft. long, and fitted with the concrete caps. These columns were tested in the same furnace and under the same loading conditions employed in the previous tests.

The supplemental tests were satisfactory in every respect. All the columns failed in the column shaft, after the area had been reduced to the breaking point by burning. The six columns withstood the test for periods ranging from 78 to 112 minutes, contrasted with periods from



Design of reinforced concrete column cap for timber columns

25 to 30 minutes when tested with cast iron and steel plate caps.

The insulating value of the reinforced concrete caps is well emphasized in the temperatures recorded at the center of the column, under the cap. With the reinforced concrete caps the maximum temperature at that point was 195 deg. F. With the metal caps the maximum was 685 deg. F., although the period of exposure was less than one-third of the period in the case of the concrete caps.

The mixture used in the cap designed by Mr. Ingberg was 1: 2/3:1 1/3. There is no record of the water-cement ratio employed. Inasmuch as the caps would have furnished protection for a much longer period than the resistance-period of the column shafts, it is probable that the mixture used was considerably richer than necessary. It would be well to experiment with mixtures of about 1:1:2 and a water-cement ratio of four gallons of water to the sack of cement, or even with a mixture of 1:1½:3 and a water-cement ratio of 6.

Light-weight aggregates may be used, in order to reduce the dead weight of the cap, and for the further reason that several light-weight aggregates that are now available in commercial quantities have excellent fire-resistive properties.

The cap shown in the design is intended for a 12-in. square column. This size contains 2.4 cu. ft. of concrete and about 15 lb. of reinforcing bars. If the concrete were made of ordinary stone or gravel aggregates the weight of the cap would be about 350 lb. If the aggregate were crushed slag the weight would be considerably reduced, although an actual estimate of weight is difficult because of the variation in the weight of slag from different sources. With haydite or lytag employed for both coarse and fine aggregate the weight of the cap would be 240 lb. or less.

A large project might utilize a hundred caps. Taking the 12-in. column size as the average, 9 cu. yd. of concrete and 1,430 lb. of steel would be required for the hundred caps. Assuming further that the mixture will be 1:1½:3 with a water-cement ratio of 6, the following approximate quantities of material will be required for 100 caps.

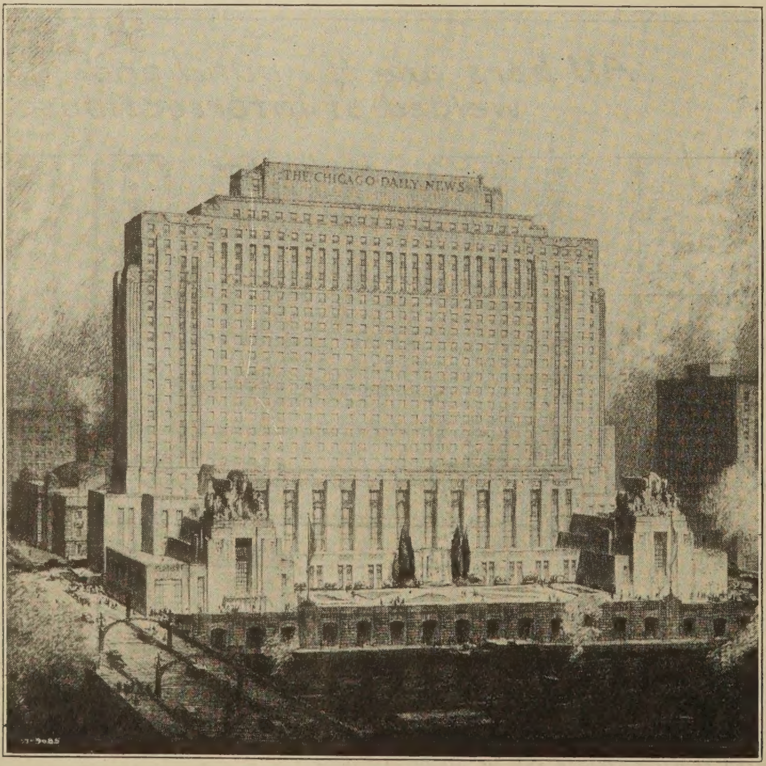
Coarse aggregate	7.5 cu. yd.
Fine aggregate	3.8 cu. yd.
Portland cement	72 sacks
Reinforcing steel	1430 lb.

Any products manufacturer, knowing the cost of his aggregates, can readily determine the cost of the material alone. For illustration, if the coarse and fine aggregates cost $2.00 a cu. yd., the cement 60 cents a sack, and the reinforcing steel 5 cents a lb., cut and welded as detailed, the cost of the material alone will be about $137 for 100 caps, or $1.37 each.

The marketing of a specialty of this kind requires facilities to do special work on short notice. The more commonly used sizes might be carried in stock, but almost every project would require special sizes or shapes. The reinforcing steel would be bought completely made up and welded for each cap.

This cap, because of its size and the attention to details required, would appeal only to a products manufacturing organization equipped to handle specialties and supported by a sales force. The market possibilities for this unit, in any given locality, are well worth careful investigation.

WE HAVE MOVED



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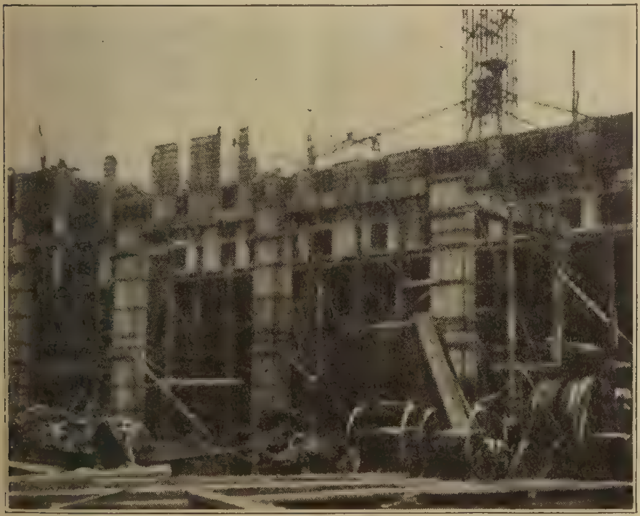
Material Delivery Determines Contractor's Plant Layout

Plant Arrangement Determined by Avenues Through Which Materials Were Received—Belt Conveyor Takes Dry Proportioned Aggregates From Dock to Mixers—Two Types of Concrete Placed

WHEN the White Construction Co., of New York came to the job of building the new dock and warehouse for the New York Dock Co., at the corner of Joralemon and Furman Streets, Brooklyn, the season was already far advanced. Speed was essential, both to get the building finished on scheduled time and to complete the pouring of concrete before cold weather imposed additional handicaps. In obtaining speed, the contractors applied original and interesting methods.

The belt conveyor transporting aggregates from the batching plant at the water's edge to the mixer



The job layout was planned so as to reduce tie-ups in the delivery of materials. An avenue of approach was reserved for each of the principal groups of materials

The building—a large dock and warehouse—consists of a main building 220 ft. by 374 ft., twelve stories in height and with a penthouse and tower four stories above the main section. There are also railroad sheds, adding another 125 ft. to the 220 ft. dimension, and reaching to the third story. The dock forms one face of the building, the railroad sheds another and streets the other two. The building is laid out in the form of a letter "H" with the elevator shafts at the center.

Delivery of Materials

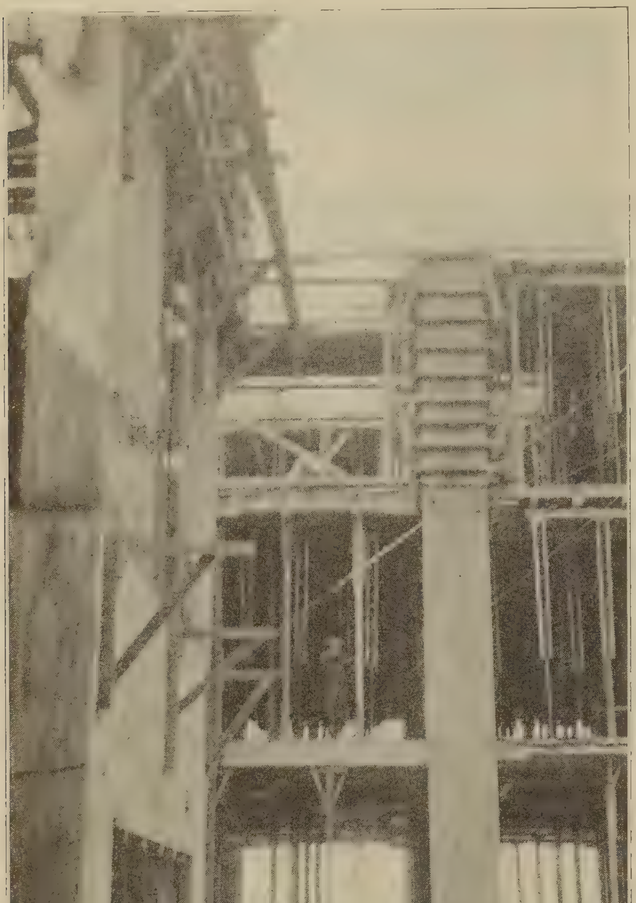
The contractors determined when construction began that it was necessary to keep each avenue of approach to the new building restricted to one line of traffic to reduce tieups in the delivery of essential materials. The originality of the job layout is dependent on this fact.

The concrete mixing plant was installed at the center of the building in the elevator shafts and pouring was done from towers. At this mixing plant two one-yard mixers were installed, one of them handling throughout the job the 1:1½:3 mix used on the columns, the other 1:2:4 mix used on the floor slabs and curtain walls.

Over each mixer was a batch hopper. The aggregates were transported to the job by water (water transportation being very cheap at this point) and a belt conveyor constructed, 165 ft. in length, direct from the dock to the mixing plant. Two proportioning bins were installed at the dock. The aggregates were then fed directly into these proportioning bins from the lighters by clamshell derricks, and delivered by the batching bins to the belt conveyor, which in turn delivered them to the hoppers at the central mixing plant. As the proportions were the same in both types of concrete, only a single belt line was needed, the cement content being added at the mixers.

The cement for the job was delivered, partly by water and partly by rail to a nearby dock, and hauled from this point by trucks. The trucks entered the building on one of the street faces, delivering their loads to be piled just inside the building. From this point they were carried to the mixers as needed by a roller conveyor.

The third line of traffic entered from the other street face and consisted also of trucks; these bringing the reinforcing steel. Job elevators were constructed up the outside face of the building at the point where the trucks delivered their loads, and the reinforcing bars were delivered direct to the elevators and carried by them directly to the floor being worked on.



850 *cu. yd. of concrete were poured per day, completing one floor per week*

Considerable economies in handling were effected on all three materials in this way, together with the complete elimination of all traffic delays.

Placing Concrete

For the column members, wooden forms constructed by the White company were used, Des Lauriers metal forms being used for the floors and slabs. Pouring proceeded at a rapid rate, 850 yards a day being poured daily throughout the progress of the job, and one floor being finished every week during the entire working period. As the two mixers were working with different types of batch, it was possible to pour the floors and walls almost as fast as the column members, floors, walls and stairs being only one floor behind the columns throughout the job. Columns were allowed to harden from five to six hours before pouring adjoining floor slabs, and forms for the floor slabs were left in position for three days extra as a safety measure.

Another interesting feature of the job is the fact that electric power was used throughout. The contractors declare they found it both more flexible and cheaper than steam power, and it had the great additional advantage that it was possible to convert many of the construction power lines into permanent power lines for the building.

A. S. T. M. Committees Hold Meetings at Chicago Under New Plan

The annual spring group meeting of committees of the American Society for Testing Materials was held at Chicago on March 19th to 22nd. This was the first trial given by the society of the plan of holding a number of committee meetings over consecutive days and results are reported to have been highly satisfactory. A total of 93 meetings was held, including both committee and subcommittee. Two of the former, of particular interest, were those of C-9 and 10, on Concrete and Concrete Aggregates and on Hollow Masonry Building Units, respectively.

An outline of Committee C-9 reports includes the proposed revision in the Standard Method of Making and Storing Specimens of Concrete in the Field to include more adequate instructions for securing curing conditions more nearly comparable to those of the structure. Work is also being carried out looking toward the suggestion of revisions in a number of sections of the 1924 report of the Joint Committee on Concrete and Reinforced Concrete. It is likely that a new specification will be proposed outlining the standard procedure for carrying out flexure tests on concrete beams for use in the control of concrete.

Among the projects on which work is being carried out but on which no report is anticipated this year are mentioned standard procedure for making specimens of concrete where large size aggregate is used; method of testing drilled cores as a basis for acceptance of concrete work; relation of abrasion test for slag to its concrete-making properties; relation of shape of particles of aggregate to their cross-bending and compressive strength and the development of a method for measuring workability of concrete.

At its meeting, the products committee previously mentioned considered the substitution of the word "structural" for the word "hollow" in its specifications, as well as the use of capping material, for use in compression testing, composed of a mixture of sulphur and clay. This would permit the testing of units immediately after the cap is placed and would give ultimate strengths more nearly representative of the true strengths.

New Kansas City Engineer

Ernest R. Rogers has been appointed district engineer of the Kansas City office of the Portland Cement Association, according to announcement made by Wm. M. Kinney, general manager of the organization. In this position he succeeds R. M. Simrall, resigned.

EDITORIAL

The Job Is the Thing

WHEN anyone seriously sets out to master any subject, he may expect to find the subject becoming increasingly difficult and complex as he makes progress. The higher one climbs up a hill, the farther the view extends.

Recent years have seen much progress in the concrete-making art. In the field and in the laboratory engineers have set themselves the task of mastering the principles underlying the use of this astonishingly versatile material. And it is only natural that as progress is made, the horizon widens. One problem approached creates, or rather leads to, the discovery of new problems.

All this may seem hopelessly confusing to those in the industry who deal mostly with the practical end of the work and who are more concerned with results than with theories. They hear of this technical investigation or that elaborate series of experiments and they wonder what it is all about from their standpoint—the job.

Yet every investigation has, as its primary object, some discovery that will be of direct interest to the man in the field. It may be workability, predetermined strength, durability, watertightness or some other end that is sought. Whatever it is, it aims directly or indirectly at better job conditions.

As a result there has accumulated a vast amount of helpful material. Practically every important advance in the art has been brought about through the application to job conditions of some fundamental principle that first saw the light of day in a laboratory. In the laboratory it was "technical." When applied to the job, it was "practical"—it worked.

Ordinarily the man on the job will not wade through "technical" papers to discover there some new principle that he may apply to his work. He does not have the time nor the inclination. But he will be intensely interested in knowing how his fellow concretor is handling his job. If his neighbor is applying a new method, he wants to know it and he wants to know "how it worked." Then he can be induced to try it also.

The adoption of quality control methods illustrates this fact. At first only a very few contractors would undertake a job under those conditions. Now they insist on them and quality control jobs are the order of the day. The thing that sold quality control to the contractor was not the water-cement ratio law, but the experiences of other contractors who had actually tried it and proved its advantages.

Progress in the making and placing of concrete can come only through the exchange of job experiences. It is only when the men in the field actually apply the principles of making quality concrete that real progress has been made. It is not enough to ***know*** how to make good concrete. It must actually ***be made.***

◆

Out of the Basement

THE steadily growing number of jobs in which concrete block are being used in skyscraper business buildings and large apartments are opening products manufacturers' eyes to newer and infinitely larger markets for concrete products. The products manufacturer is finally getting out of the basement into his proper element.

Up to the present time only a comparatively few products manufacturers have entered this field. The development of this and other large possible markets has barely been started. Yet, in such jobs lies the future of the industry.

There are still too many products manufacturers who are victims of the "basement complex." Until they learn to think in terms of 18- and 20-story buildings they are going to pass up many possible jobs. Once they have gotten out of the basement mentally, they will begin to follow with their sales.

◆

Modern Cement Needs

JUST one year ago an editorial under the above caption was published on this page. In that editorial the statement was made that "For some time past there has been developing a demand for a new type of cement," and it was suggested that the time was approaching when more than one standard specification would be necessary.

Events since then have emphasized that need. Everywhere cements are offered to the buyer that are claimed to exceed the specifications in this or in that particular. And the buyer has no standard specification by means of which he can measure these additional qualities.

The result is that he takes matters into his own hands and writes his own specifications, and the advantages of standardization are lost. There is only one constructive course open and that is the early adoption of a new tentative specification covering those additional qualities that the user is demanding.

P. G. RILEY
President

T. G. McGOVERN
General Supt.

P. G. RILEY

GENERAL CONTRACTOR

~~701 Temple Street Bustown, N. Y.~~

Los Angeles

Dear Mac:

Well, Mac, John Brundage was over again last evening. His wife is still in the East—so John drifts in quite often of an evening, because as he puts it, his home is like "near beer"—not a kick in it.

We got into an awful argument, which started by his telling me about the mixer factory he had been in active management of for years, up until his retirement two years ago. It seems this company, which always had the reputation of building high quality, high priced machines, was now designing some light-weight, low priced machines and John was broken-hearted about it.

So I said, "John, isn't every man his own master?"

"Yes, P. G., that's what I asked the boys who are running my business now, and the sales manager's 'come-back' was, 'the consumer is the master in this industry and not the manufacturer, so it behooves us to manufacture machines that can be sold at the price the consumer seems to want to pay for them. A careful analysis has been made by us of sales of these machines, to find what price was popular with the buyers; in other words, down to what price the buyers have tried to beat the price of a quality product. Now, we must build a product as good as we can to meet that price and if possible, design inexpensive but attractive selling points into the product, for if that is what buyers want instead of long life, low upkeep and production, let's give it to them.' And that is what the boys are going to do.

"P. G., you have never thought of it, I know, but buyers of equipment have themselves to thank for having equipment that gives trouble, for every time they nick off a dollar from a quoted price of a quality product, they join thousands of other 'nickers' and by constantly nicking, they just naturally chop down quality to fit the price they ask, for manufacturers are going to give the buyers what they want.

"Troubles cannot be eliminated by aiming at low prices.

"After an epidemic of a buyers' market, there follows an epidemic of troublesome, cheap-price, light-weight products. I have never seen it to fail.

"The buyer can raise the standard of quality in equipment by forgetting price and demanding high quality. Then troubles and delays will be designed out of equipment.

"Beat down prices and demand trade-ins and manufacturers will compete to give you cheap priced equipment. Say—'To Hell with that quality stuff—what I want is a machine to last through this job, so give me low price,' and you might just as well say—'To Hell with profits and peace of mind,' and bear in mind the buyer controls the quality of equipment by the price he pays. He also controls the trend of design and by paying the price for quality he is promoting a better product."

John got all "het" up, Mac, but I believe he is right.

Yours truly,

P.G.

Modern Practice in Cements and Concrete

A Summary, from the Job Point of View, of Improvements in Cement, Aggregate, Equipment, Job Methods and Concrete Control in Modern Construction

By L. G. LENHARDT
Assistant Engineer, Department of Water Supply, City of Detroit, Mich.

BEFORE considering the modern technique of concrete making, we must first consider the modern materials with which to make concrete. The first of these, naturally is, the cement. Cements have undergone a considerable improvement within the last few years. This change has been more marked since the adoption of the last A. S. T. M. specifications known as C9-26. There now seems to be an effort on the part of cement companies to sell by brand and quality, which implies an effort on the part of the mill to achieve some claim for distinction. All of this tends to improve the material placed in the hands of the user. There are numerous cements placed on the market for their high early strength properties. Others are being advocated for their waterproofing qualities, resistance to sulphate water, plasticity of the concrete, etc. Generally speaking, cements can be grouped as follows:

1. Ordinary portland cements.
2. High early strength portland cements.
3. Super cements.
4. Waterproofing cements.
5. Alumina cements.

In the aggregate field we find an ever-increasing number of pits and quarries catering to high grade specification material. Plain bank run and crusher run aggregate is becoming more and more a thing of the past. While there is still a large amount of this material on the market around large centers of population, this percentage is becoming less due to demands of architects and engineers for a higher quality aggregate.

Cement Research

Within the last decade and particularly within the last two or three years, the question of what constitutes portland cement has been the subject of very important and intensive research. Efforts are being made in foreign countries and the United States to determine what happens when portland cement sets and what the chemical constitutents are that produce this set. The United States Bureau of Standards has been the leader in this field and has actually made an artificial portland cement out of the pure chemicals. Indications are that the active chemical compounds that produce the set in cement are:

1. Di-calcium silicate.
2. Tri-calcium silicate.
3. Tri-calcium aluminate.

Of these the first two are the most important comprising as they do the greatest bulk of the cementing material.

The last ten years have also seen great strides in devising ways and means for predicting the strength of concrete, given known materials. Of these the two most important are the water-cement ratio theory and the mortar-void theory. The first of these theories states that a definite relation exists between strength and the volume of water used in a mix as long as the concrete is kept workable. The second of these theories is in reality supplementary to the first and states that the strength of concrete is equal to the strength of the mortar of the concrete, other things such as the water content, etc., being equal. The mortar-void theory tries to explain some of the apparent inconsistencies contained in the water-cement ratio theory. Among these inconsistencies which the writer desires to point out are the differences in strength obtained with different degrees of workability even though the water-cement ratio is kept constant and mixes are kept within the range of workable mixes. However, given a measure of judgment and sound experience as a background there can be no doubt but what satisfactory results can be obtained with either of these two methods.

The development of the theory of predicting concrete of known strength has made it possible to utilize aggregates that would heretofore have been rejected. It also makes possible the better utilization of aggregates that are in the field. Instead of blindly trying to hit a 2000-pound concrete with the best of aggregates and the utilizing of excess cement, nowadays the competent engineer shoots for 3000 pounds and higher strengths with five-bag concrete and gets results. In some sections of the country the utilization of low grade aggregate, particularly the very heavily sanded aggregates, is an economic necessity. With the tools provided by the water-cement ratio theory or the mortar-void theory the engineer can be certain of obtaining good results.

The adoption of a year-round program of building construction has taxed the resources of the concrete industry to the utmost to provide ways and means of getting good concrete every day regardless of weather conditions. With a better knowledge of concrete, the industry has become more certain of its ground. With the heating of aggregates and mixing water, the use of high early strength cements, the use of chemical accelerators which also tend to lower the freezing point, protecting and heating of the freshly placed concrete, the engineer can now obtain high quality concrete on the coldest days. Of course the effort and the extra expense mean that winter construction will cost somewhat more but in the end this extra cost is small compared to the interest on the money invested in a structure tied up through weather conditions.

High Early Strength Cements

High early strength cements and alumina cements are obtaining an ever increasing importance. High early

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Abstract of a paper presented before the twenty-fifth annual convention of the Michigan Engineering Society at Grand Rapids, Michigan.

strength concrete has been defined as unusually high grade concrete. In a sense this is true. However, there are some cements on the market that will give high strengths at three days and approximate normal portland cement strengths at a later period. Generally speaking, high early strength concrete is obtained by using rich, low water-cement ratio mixes and a portland cement of proven high early strength properties. Occasionally an accelerator such as calcium chloride is added which tends to increase the early strength. For high strength 24-hour concrete alumina cement is usually used although some remarkable work has been done with portland cements in this direction. Adequate mixing time, proper curing and careful selection of aggregates aid in securing high early strength concretes.

The time of mix has been the subject of a large amount of investigation. The Portland Cement Association advocates not less than 60-second mixing based upon their investigations. From the data they have submitted this seems proper. They have found that mixing up to 5 minutes increases the strength in all cases and in some cases mixing for considerably longer periods will increase strength. Lately the United States Bureau of Public Roads has investigated time of mix on various road jobs scattered throughout the country. From the results of these investigations it appears that under job conditions on road work 45-second mixing time gives practically as good results as minute and one-half mixing time although they are not prepared to cut mixing time as low as three-quarters of a minute inasmuch as they believe that it provides an insufficient factor of safety for practical operations. They recommend that a minimum mixing time of one minute be adopted as being consistent with reasonable uniformity and adequate strength of the concrete.

Accurate Measurement of Materials

There has been a vast improvement within the past few years in the methods available for the measuring of the materials entering into the mix, including water, cement, sand and coarse aggregates.

The measurement of water is always fraught with a great deal of difficulty as the amount of water in a mix includes not only the added mixing water but the water contained in the aggregates. Vast improvements have been made in measuring the mixing water and the most common and successful type of water measuring tank today seems to be a tank whose water content depends on an overflow pipe which can be set for a predetermined amount of water but there still remains the difficulty of measuring the water contained in the aggregates. It is possible to overcome this by the use of an inundator which allows taking care of the water in the sand but does not consider the water in the coarse aggregate which, however, is usually small. Another method of measuring moisture in the aggregates is by means of hydrometers, the water in the aggregate being absorbed by a saline solution and the reduced gravity of the saline solution tested by the hydrometer. Of course, field tests can also be made by evaporation and similar methods but these methods are necessarily slow for normal operations. Loss of mixing water through absorption normally is so slow as to be negligible but it may be a very appreciable amount may be absorbed, depending upon the material. Most materials placed on the work usually contain all the moisture they will take up and any correction for absorption will be found unnecessary. However, certain limestones and sandstones will absorb additional moisture in which case the absorption must be measured.

The weight and volume of cement per sack is quite uniform. Where sack measurements are used, the biggest source of error is in emptying the sacks, some cement always remaining in the sacks. As this error will probably not exceed 2 per cent of the total amount of cement, for ordinary work this may be disregarded. In batches where a sack of cement must be split the error may be considerable but with the range of mixers on the market today there is no necessity for mixes calling for half-sack measurements. With the increasing importance of bulk cement, weight measurements of cement are being used more frequently. With the scales in working order this should give exact results. However, the very fine nature of cement causes it to form a dust around the scale beams and knife edges which may result in error unless these are cleaned frequently.

The measuring of loose sand is difficult because of the bulking due to moisture. However, the volume of dry sand is constant so proportions must be based upon a dry condition and in actual measuring corrections must be made for bulking. There are two methods available for accurately measuring sand—inundation and weighing. With inundation the sand is measured under water which gives the same volume as dry sand. With weighing, corrections must be made for moisture content which, of course, means field tests for corrections as conditions change.

The two methods in general use for measuring coarse aggregate are either by volume or by weight. Since bulking of coarse aggregate is usually small, volume measurements give fairly accurate results. More accurate results are obtained by weighing, but moisture must again be corrected for.

Core Tests

As a check on placement and on quality of work cores are being resorted to more frequently in all classes of work, more particularly on state highway work. On paving work the cores are an excellent check on both the thickness and strength and have tended to improve the quality and workmanship on road work. On other than highway work coring is fraught with difficulty due to the fact that reinforcing steel may be encountered. Not only is it impractical to drill through reinforcing steel with our present methods of drilling but the cutting of a bar in a structure for instance may imperil the integrity of the structure. However, there are certain classes of work other than paving where coring can be done to good advantage, such as tunnels and mass concrete work where reinforcement is not used. The Detroit Water Board has done extensive core drilling in the water supply tunnels and the sewer work in the city of Detroit is also now being cored.

Modern Specifications

As an indication of the trend of the times may be mentioned that 36 cities are now specifying a water-cement ratio in their building codes. These cities range from Sacramento, California, to Springfield, Massachusetts. Twenty railroads are using a water-cement ratio specification and there are countless other examples in other fields of activity. In Michigan, the Detroit Edison Company were probably the pioneers in modern concrete practice. Grand Rapids, Michigan, was probably the first Michigan city to use a water-cement ratio specification on a large scale, it being used very successfully on the large sewer program which is now practically completed. Probably the biggest single piece of work undertaken in this state using water control for concrete has been the Detroit water tunnels which were started in 1926, where, by the time all the work is finished, better than 200,000 cubic yards will have been placed with water control specified. The Penobscot Building in Detroit is perhaps the greatest outstanding example of the use of modern practice in the line of building construction. This work was very carefully supervised and controlled by a concrete testing laboratory installed upon the work. There are countless other examples that may be cited of the use of modern control methods in this state and there can be no doubt that on the whole the quality of the concrete has improved through the use of modern practice.

* * *

Discussion

By J. H. WASSON

Engineer Representative, Peerless-Egyptian Cement Co.

IN order that we may properly measure or judge the advances being made in cements and concrete as outlined by Mr. Lenhardt, it is essential that we have the right "measuring stick" or that we know and recognize the limitations of the "measuring stick" we use. Maximum serviceability of the concrete in place is what is wanted. Any measure of the qualities of concrete is a good one insofar as it is a true and accurate measure of the serviceability of the concrete in place. The one point which I would like to bring out in this brief discussion is that it is my belief that we are tending to place too much dependence on the concrete cylinder strength test as a sure method of measurement of the improvement in the concrete due to the factors affecting quality of concrete as referred to in Mr. Lenhardt's paper. I am a strong advocate of cylinder tests, but I feel that they have limitations as to the qualities of the concrete which they measure, and that they should, therefore, not be blindly accepted as an index of the value of all concrete for all purposes.

Limitations of Field Cylinder Test

In order to get clearly in mind the limitations of the field cylinder strength test as referred to above, let us consider for a moment the manner in which the standard cylinder is made. The A. S. T. M. standard for making specimens in the field reads as follows: "The test specimens shall be moulded by placing the concrete in the forms in layers approximately 4 in. in thickness. Each layer shall be puddled with 25 to 30 strokes with a ⅝ to ¾ in. bar about 2 ft. long, tapered slightly at the lower end." Assuming that an average of 80 thrusts of the rod are made for the three layers in one cylinder, then we have the equivalent of 400 thrusts per cu. ft. of concrete since one cu. ft. of concrete will make approximately 5 standard 6 by 12 in. cylinders. Anyone familiar with concrete field practice will, I believe, agree that there is very little job concrete that is puddled to anything like the equivalent of 400 thrusts of a ⅝ rod per cu. ft. of concrete. What this means is that harsh unworkable mixtures and smooth working mixtures, as well as all gradations between these two extremes, are all brought to a common level when made into a cylinder. The advantage of the smooth working quality of one concrete mixture which is of maximum importance in practice, is practically eliminated because of the large amount of puddling in making the cylinders.

When concrete is placed in forms there are two forces which may be considered to act on it and cause it to settle around the steel and into the corners of the forms making a dense homogeneous concrete in place. The force of gravity is always present. Forces due to puddling, tamping or vibrating may or may not be present. A great deal of concrete is placed without any spading or puddling whatever. If we think of the sand particles being contained in a cement-water paste, and the coarse aggregate being contained in the cement-sand mortar we can readily see that the more smooth working, or less harsh the mixture is, the more dense, homogeneous, and watertight, the resulting concrete will be due to gravity alone, or to the combined effect of gravity and puddling or tamping. Time of mixing, grading of aggregates, amount of mixing water, adequate cement content, and plasticity of the particular cement, affect very materially this smooth working quality of a concrete mixture.

Due to the manner in which concrete test cylinders are made, as pointed out heretofore, strength tests do not by any means necessarily measure all the desirable qualities of a concrete mixture. Cylinder strength tests together with close observation of the condition of the concrete mixture as it settles into its final resting place in the forms will give a very good idea of the strength, uniformity, and impermeability, of a concrete structure, and therefore of its ultimate durability and serviceability. Let us use the cylinder test but let us recognize its limitations.

British Investigate Mixing Periods for Pavement Concrete

A recent intensive investigation to determine the effect of the length of the mixing period on the quality of the resulting concrete, made by British engineers, has shown that when high-grade mixing machines are in use neither strength nor uniformity of test results is improved by mixing the concrete over 45 seconds. However, as three-fourths of a minute mixing provides an insufficient factor of safety for practical operation, and as it is doubtful whether construction processes other than the mixing operation itself could be speeded up sufficiently to take advantage of the marginal time fraction, it is recommended that a mixing time of one minute be adopted as the minimum, consistent with the assurance of reasonable uniformity and adequate strength of the concrete. There is strong evidence to prove that thoroughly satisfactory concrete can be produced by pavers in good condition with a one-minute mixing period.

It appears that the test results showed that there were no differences in strength between concrete mixed for 45 seconds and that mixed for three minutes. On the other hand, concrete mixed for only 30 seconds was unsatisfactory, so that it is evident that 45 seconds is too narrow a margin of safety to allow for the normal irregularities met with in practical work.

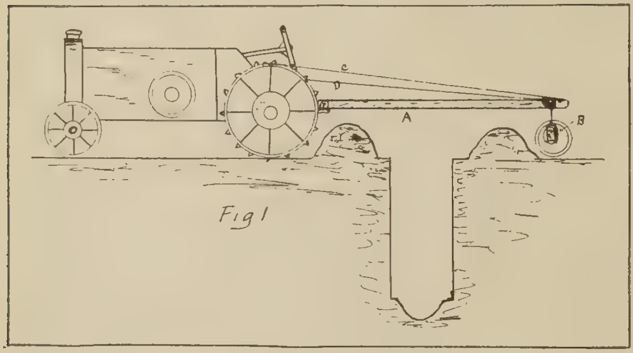
During the construction of a concrete road, recently completed, several test cylinders of the concrete used were aged and tested. It was found that after seven days the concrete had a compressive strength of 2,420 lbs. per sq. in., and at 28 days the average was 4,582 lbs. per sq. in.—nearly double the strength of the first average taken 21 days before. During the progress of the work a number of beams were made, from time to time, when the concrete was being put into the work, and these showed an average modulus of rupture of about 715 lbs. per. sq. in. for concrete 14 days old. Throughout the length of the road, at about 500 ft. intervals, cores were cut out and tested, and these showed not only that the concrete was of uniform quality and thickness, but that there was an average compressive strength of 5,030 lbs. per sq. in. for the concrete, at an average of 90 days.

Practical Kinks from the Job

Speeding Up Tile Laying

With 360 acres of our farm lying on the Platte Valley flats of Nebraska, we discovered that a considerable portion of this would grow better crops if some of the subsurface water was drained from it and after arranging with the county to help defray the expense of building a road if they would construct the ditch at the side of it deep enough to form an outlet for tiling, we agreed to spend $20.00 an acre to drain it.

The farm tractor was used to great advantage in most of the work from the beginning to end of the tiling operation. About one-third of the earth was thrown from the trenches by its power. The tile were hauled from the factory with it and the trenches were filled by its use. But the part of the work which was most speeded up was the laying of the tile in the trenches. A part of these were placed direct from the hayrack on which they were hauled from the factory, and a part were placed from where they had been unloaded along the side of the trenches.



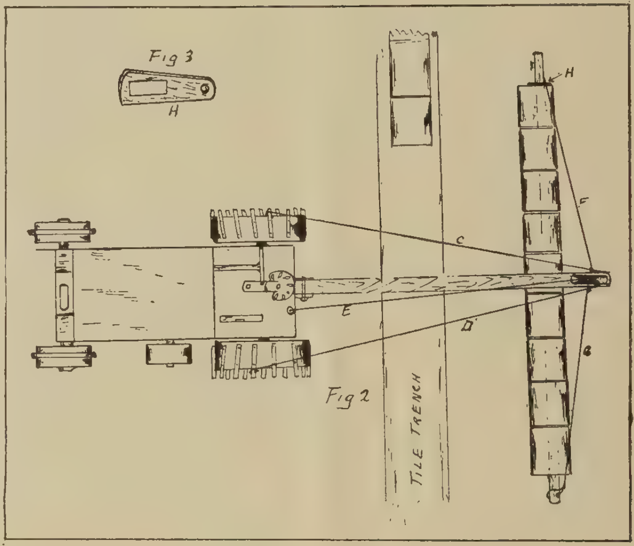
First, to level off the bottom of the trenches so that the tile when laid would correspond with one another, a log with a diameter the same as that of the tile was dragged along the bottom. This removed all the small uneven humps and filled the cavities so that when a tile was placed it rested solidly.

The drawing (Fig. 1) shows how the tractor was then used to lift the tile and carry them over the trench ten to a dozen at a time and lower them in place, with two men. The work was done about seven times as fast as the same two men could do the work by hand.

A 4- by 4-inch timber (A) 12 feet long was pivoted to a block and clamped to the rear of the tractor at the draw bar. The outer end of this 4-by-4 was slotted and a pulley fitted in the slot. A rope (E) passing over this pulley is attached at the outer end to two other ropes (F and G) and these latter to a 2-by-4 which passes through the tile to be set in the trench. One of these latter ropes is tied to one end of the 2-by-4. The other end is tied to a plate as shown in Fig. 3. This is made of $\frac{1}{8}$-inch plate iron with the slot large enough to pass easily over the end of the 2-by-4 timber.

Two ropes or steel cables (C and D) are attached to the outer end of the 4-by-4 arm and the other ends are equipped with hooks made of $\frac{5}{8}$-inch round steel of a size that may be hooked over the mud lugs of the drive wheel of the tractor.

The method of operation is as follows: The tractor is backed to the thrown out earth as shown in Fig. 1. The 4-by-4 rests over the fifth or sixth tile. The 2-by-4 (B) is placed through about ten of the tile and the plate (Fig. 3) is placed over the end of the 2-by-4. The rope (E), passing through a hole in the wood block clamped to the rear of the tractor frame, is held from slipping by the tractor operator. The hooks on the cables (C and D) are hooked over mud lugs near the top of the drive wheels and the tractor then moves slowly forward. The action lifts as many tile as are on the 2-by-4 and at the same time carries them to a position over the trench. The rope (E) is now allowed to slip through the hole, lowering the tile to the bottom of the trench. As they near the bottom, the helper shifts them so that they rest in correct position to conform with those already laid. As some slack is given the ropes, the 2-by-4 is drawn out. The slotted plate is released and the rope (E) is drawn up by hand until the knot where it joins (F and G) comes in contact with the pulley. Here it is snubbed again. The tractor is reversed, the two hooks released and the tractor maneuvered to position for the setting of another bunch.



Tractor and Bulldozer Replace Pick and Shovel Gang

The accompanying illustration shows how the pick and shovel gang was eliminated in the construction of a new building in Oakland, California. A caterpillar tractor equipped with a bulldozer did the work of filling in around the columns much quicker and cheaper than the usual manual labor.

Effect of Recent Mix Design and Control Upon Field Concrete

Greater Uniformity and Improved Quality of Concrete Secured by the Michigan State Highway Department Through Mix Design and Quality Control Methods—Proportioning by Weight—Modulus of Rupture Tests—Conclusions

By **CLIFFORD E. FOSTER**
Chief Engineer, Michigan State Highway Department

DURING the construction season of 1928, the Michigan State Highway Department changed from the volumetric method of proportioning aggregates for concrete paving mixtures to that of weighing the fine and coarse aggregates. This action was taken because it had been demonstrated, first in Iowa, and later in other states, that the weighing of aggregates was entirely practical and admittedly more accurate than volumetric proportioning.

From our study of core drill records and from observation of the behavior of our pavements and concrete structures in service, it was learned that the quality of concrete obtained in previous years varied widely over the state as a whole. In fact, the data indicated that uniform quality could not be depended upon, even on single projects. This was due, not to any lack of conscientious effort to secure good results, but from inherent weakness in the method of design and control of concrete mixtures then in use throughout the country at large.

In looking to the probable causes of lack of uniformity, it became apparent that there were several factors which have a very decided effect upon the strength of the concrete, of which the method of measuring the aggregates was only one.

Proportions

Any mix proportion such as 1:2:3½ is at best an arbitrary ratio which is specified because tests have shown that in general it will produce a 3000-lb. concrete in 28 days —provided good aggregates are used and ordinary good practice of mixing and placing is followed. No account is usually taken, under a specification of this kind, of the possibility of the most effective combination of the ingredients without disturbing, in any way, the unit cement content or cost per cubic yard. But there certainly is a combination of the cement, water, fine aggregate and coarse aggregate which, with proper workability, will produce the minimum strength possible for the particular materials furnished for the work. The arbitrary specification of set proportion might produce maximum strength but most likely will not do so. Therefore the conversion of the volumetric ratio of 1:2:3½ to the same ratio by weight, leaves much to be desired in the way of quality improvement—although it must be said that this procedure will undoubtedly increase the uniformity of the results be they good, medium or poor. So it naturally follows that for the best results, each mix must be designed for the most effective combination of the materials available. This, of course, involves careful laboratory work for each job and close control of field operation.

The mix may be designed either for a specified strength or a maximum strength for a given cement content per cubic yard of concrete. In view of the fact that it seemed desirable to learn just what field strengths of concrete were obtainable by careful design and control, it was decided to adopt the latter method for the first year's work.

From past experience it was evident that, under most conditions, the cement content of the 1:2:3½ specification, i. e., 1.54 bbls. per cu. yd., would produce a good quality concrete. The cement content for 1928 weight jobs was therefore fixed at 6 sacks per cu. yd. and all mix designs based on that figure for the express purpose of studying the strength range obtained by field tests on the resulting concrete.

School for Field Engineers and Inspectors

Before placing the method in operation all technical personnel having to do with paving work was given a short course in the laboratory procedure. The project engineers were equipped with the necessary apparatus for testing for moisture content and unit weight of materials. They were also furnished with a transverse beam testing machine and standard weights for testing the contractor's weighing devices. The proportioning and testing work was conducted under the direction of the laboratory and the work in the field was supervised by an inspector of paving mixtures who was thoroughly familiar with the method of design and who visited each job several times during the season to observe the results obtained and to see that the proper procedure was followed.

The modulus of rupture of sample beams taken from the pavement concrete as the work progressed was carefully determined and reported to the laboratory. The data thus obtained furnished a means of studying the results obtained. The results have been reduced to graphs and charts from which a number of conclusions may be drawn and which follows:

Results

1. The weight method of measuring aggregates produces more uniform concrete than the volumetric method of proportioning. This is shown by the data presented covering the overrun and underrun of cement on typical projects on which the fine and coarse aggregate was measured by these methods. The quantities of each aggregate can be more readily adjusted by weight than is possible by volume since the matter of adjusting quantities when measuring by weight is simply a case of resetting the

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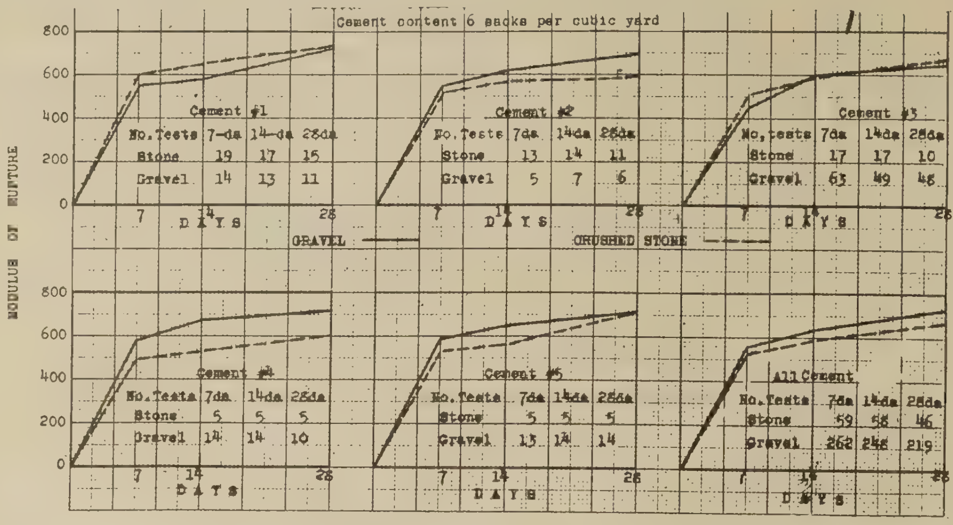
Presented at the Fifteenth Annual Conference on Highway Engineering, University of Michigan, Ann Arbor, February 21, 1929.



Curves showing relation of modulus of rupture at 7, 14, and 28 days between the two coarse aggregates, gravel and crushed stone. Modulus of rupture tests made on 6 by 6 by 40 inch beams

weights on the scale beams. In the case of volumetric proportioning, in order to correct the proportions accurately, it is necessary to calibrate the containers and make considerable computation before making adjustment. The ease of making adjustment by weight is further borne out by the records on various projects where reports show that the mix was adjusted day by day to correct for moisture and variation in the coarse aggregate.

2. The average results of the field tests show that gravel aggregate produces a higher modulus of rupture than crushed stone aggregate when the designs for these two coarse aggregates are based on the same yield per sack of cement and with the same provision for excess mortar. The apparent reason for the greater strength secured in case of gravel aggregate is because the crushed stone furnished under our specifications contains a larger percentage of voids than the gravel, consequently more mortar is required to fill the voids and provide an excess for workability for crushed stone than is required for gravel. It therefore follows that the ratio of sand to cement in the case of crushed stone is greater than in the case of gravel. Expressed in other words, the mortar for gravel aggregate is richer than that for crushed stone. It is a well established fact that the richer the mortar, the greater the strength, all other things being equal. The relation between the proportions for crushed stone aggregate and gravel aggregate on the past year's work was as follows:

For gravel coarse aggregate the proportions were:

1 part of cement to 2.13 parts of fine aggregate to 3.80 parts of coarse aggregate.

For crushed stone coarse aggregate the proportions

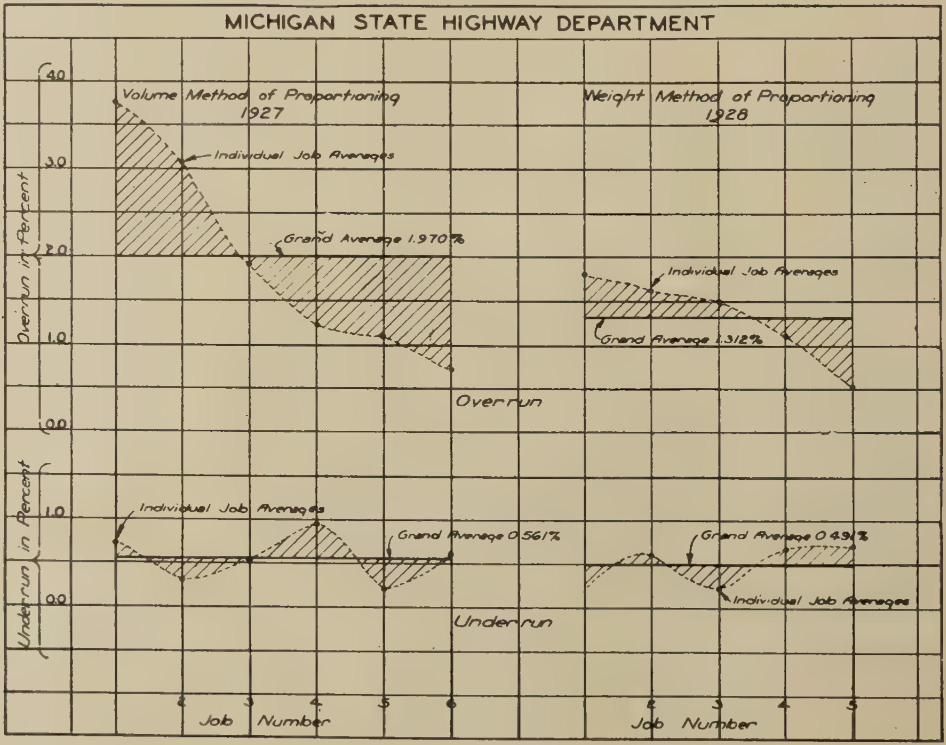
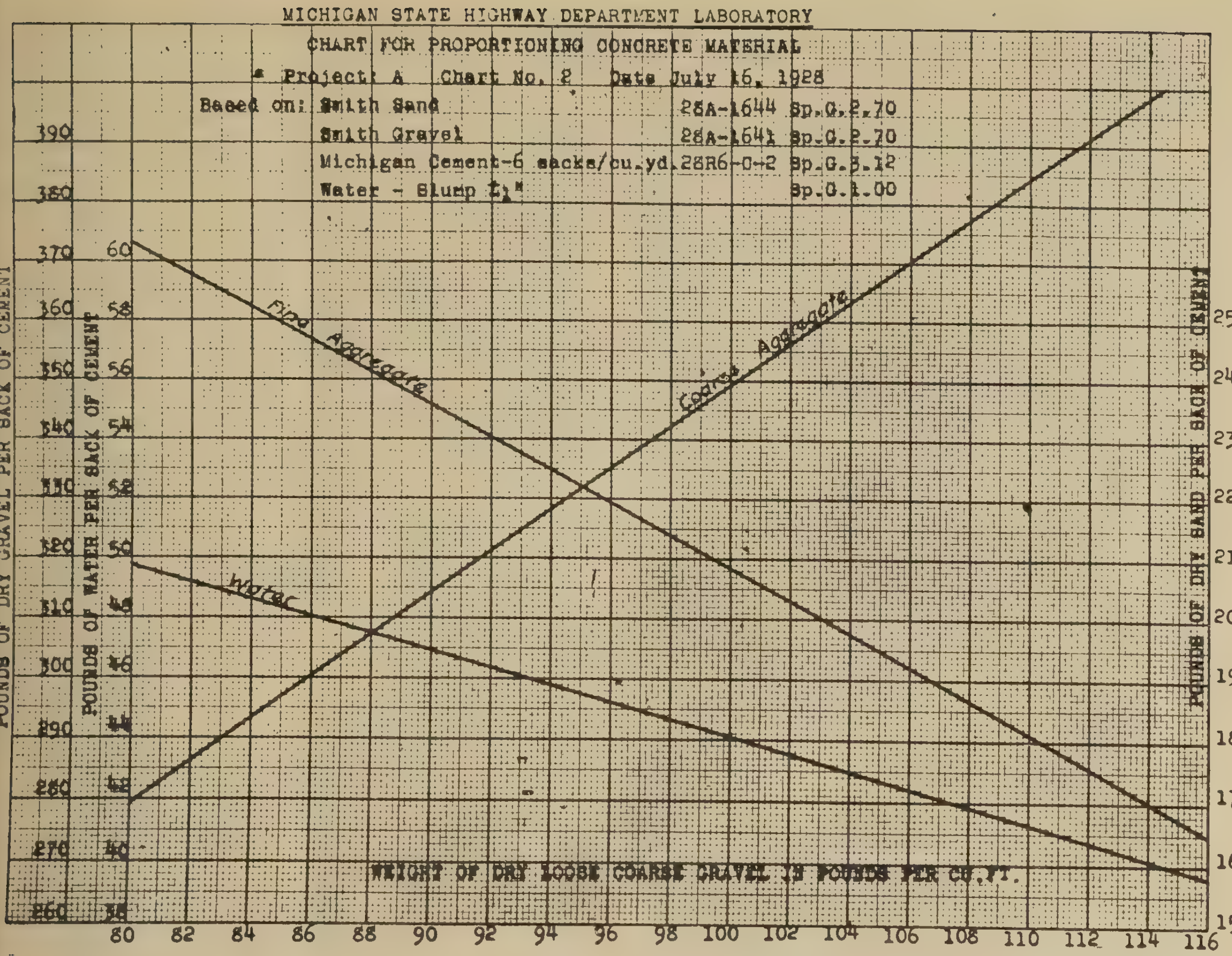


Chart showing increase in uniformity of concrete secured with the weight method of measuring aggregates



The field mix chart used on the work described. It will be noted that the proportions of fine aggregate, coarse aggregate and water per sack of cement are expressed as a function of the weight of a cubic foot of coarse aggregate. The reduction of the preliminary laboratory work to this chart renders the plant inspector's work in proportioning to a minimum, it consisting largely of the determination of moisture and checking the unit weight of the coarse aggregate

were:

1 part of cement to 2.43 parts of fine aggregate
to 3.37 parts of coarse aggregate.

These proportions were the average of 36 jobs where gravel coarse aggregate was used and 16 jobs where crushed stone coarse aggregate was used. It can be readily seen that the sand-cement ratio in the case of crushed stone is considerably higher than that in the case of gravel. If by properly grading, the voids in the crushed stone aggregate can be reduced to the void content in the gravel aggregate, there is no apparent reason why the modulus of rupture for concrete made from crushed stone cannot be made to at least equal the strength of concrete made from gravel.

Modulus of Rupture Tests

3. One of the most interesting and valuable results of the study of the field specimens is the fact that, on the average, the modulus of rupture of concrete beams is a function of the tensile strength of cement. The greater the tensile strength of cement, the higher the modulus of rupture. It therefore follows that in designing concrete mixes more consideration should be given to the quality of cement than has formerly been given. This point is given emphasis by the fact that from the chart presented showing this relation, a difference of 100 lbs. in tensile strength of the cement will make from 115 to 150 lbs. difference in the modulus of rupture of the concrete. Since the average modulus of rupture at 28 days varied, on the jobs studied, from approximately 500 lbs. to 840 lbs., it may be seen that the effect of a 100-lb. difference in tensile strength of cement might affect the modulus of rupture from 15 to 30 per cent. This indicates that the quality of cement is one of the most important factors to consider in the design of a concrete mix. It may be further deduced that, when doing preliminary laboratory work in the design of a mix for a specific project, samples of the cement to be furnished to the job as well as fine and coarse aggregate should be used. The designer, in determining the proportions of the mix, may take advantage of the quality of cement which will be used on the project providing the strength record of that particular brand is known. The design, of course, must be based upon the minimum strength developed by the particular brand. Economy of design will be effected if the cement which is furnished has a high minimum strength value. It may be that a particular brand of cement has a high average strength value. However this value should not be used in design.

Another interesting point developed is that the modulus of rupture of the beams studied was approximately 180 per cent of the tensile strength of the cement briquettes of the same age. This, of course, is an average result, but it furnishes an approximate index of what may be expected for concrete containing 6 sacks per cu. yd., using materials available in our state for fine and coarse aggregate.

4. As previously stated the design of the various mixes

during the past year was based on securing the greatest strength possible from 6 sacks of cement per cubic yard in combination with the various materials furnished on our projects. From the data secured it has been learned that the average 28 day modulus of rupture was slightly over 700 lbs. It was found that the projects grouped in order of their 28 day strength showed a range of modulus of rupture from 500 to 840 lbs. It was shown further that on a large number of projects, the 28 day average modulus of rupture was very close to 700 lbs. A modulus of rupture of 700 lbs. therefore appears to be about the strength which could be used for design with approximately the same cost for cement as under the present system of designing for constant yield. In adopting a modulus of rupture of 700 lbs. for design strength, it will be necessary to increase the cement content on some projects in order to secure the design strength. On other projects it will be possible to reduce the cement content. It appears from the data available that the increase in cement content on those projects, where an increase is necessary, will be practically offset by the decrease on those projects where a decrease is possible.

In view of these facts it has been decided to design our concrete paving mixtures for a modulus of rupture of 700 lbs. at 28 days. It is interesting to note that, on the average, the design worked out on this basis should produce a concrete with a modulus of rupture of approximately 550 lbs. in 7 days which will permit opening the pavement to traffic within that period. It was found that the 14 day average modulus of rupture was 112 per cent of the 7 day strength and the 28 day modulus of rupture was 124 per cent of the 28 day strength, but an examination of results secured with the various brands of cement indicates that these percentages vary for the different brands. Therefore, the arbitrary opening of pavements at 7 days cannot be adopted, but the time of opening will, of necessity, have to be controlled by the actual testing of specimens in the field. This program will necessitate even more careful design and control than has been in effect during the past year. Too much emphasis cannot be placed upon the desirability of accurately controlling all operations if more than average results are to be expected.

Survey Shows Increase in Public Works Construction

The enormous strides made in public works construction in the United States during the past decade is cited as a significant post-war trend in the survey of the National Bureau of Economic Research shortly to be published with the report of the Committee on Recent Economic Changes of the President's Unemployment Conference.

Figures are given showing that nearly $1,000,000,000 was expended in 1927 for waterworks, sewers, bridges, streets and roads, excavation, drainage and irrigation by counties, towns, cities, states and the federal government, whereas less than $400,000,000 was spent for the same purpose in the year after the close of the war. A comparison of present expenditures with those of the year before the war, when considerably less than $200,000,000 went for public works is still more striking.

The report will be ready for publication in May.

The total annual expenditures by years for public works, as given in the survey follow: In 1913, $192,893,000; 1919, $398,152,000; 1920, $406,729,000; 1921, $459,042,000; 1922, $521,079,000; 1923, $630,424,000; 1924, $685,673,000; 1925, $719,212,000; 1926, $811,741,000; 1927, $932,703,000.

The committee as now constituted is made up of President Hoover, chairman, Walter F. Brown, Renick W. Dunlap, William Green, Julius Klein, John Lawrence, Max Mason, Adolph C. Miller, Lewis E. Pierson, John J. Raskob, A. W. Shaw, Louis J. Taber, Daniel Willard, George McFadden, Clarence M. Wooley, Owen D. Young, and Edward Eyre Hunt, secretary.

The conclusions of the committee, as well as the survey data, will be published for public use.

Louisiana Plans Highways; Needs Contractors and Engineers

With almost $75,000,000 ready to spend for hard-surfaced roads, the state highway commission of Louisiana at Baton Rouge is preparing to extend a warm reception to reliable highway engineers and contractors.

There is now 100 miles of paved surface on the 2000 miles of state highways. It is located and graded and has some form of gravel surface. Only a small amount of relocation will be necessary. There are sufficient material pits and quarries throughout the state to supply the demand and railroads will be found near a larger part of the mileage to be paved.

It is proposed to pave first 1650 miles on 4 routes—two east and west and two north and south highways They are the Jefferson highway and the Old Spanish Trail two of the most important arteries in the state. About half of this mileage will be completed in 1929.

The improvement will be financed by bonds which are to be paid off by 25 per cent of the 4 cent gas tax.

O. K. Allen is chairman of the highway commission.

Road Builders Hold Annual Meeting at Washington

The annual meeting of the American Road Builders Association will be held in Washington, May 2nd and 3rd

The program to be followed includes an opening reception on Thursday at the offices of the association in the National Press building. On the following morning will be held the regular annual meeting of the City Officials division, and, simultaneously, that of the county highway officials.

The annual dinner of the association will take place on the evening of the 3rd and will be followed by the regular annual meeting. At this time the officers and directors elected at the January convention at Cleveland will be installed and the reports of the board of directors and retiring officers will be received.

Wheelbarrow Simplification Subject of U. S. Department of Commerce Conference

Manufacturers of wheelbarrows have requested the Division of Simplified Practice of the Bureau of Standards U. S. Department of Commerce, to hold a general conference of all interested elements of the industry for the purpose of considering a proposed simplification program for wheelbarrows.

P. H. H. Dunn, of the Division of Simplified Practice has therefore arranged for a general conference of the various elements of the industry, which was to have been held at the Department of Commerce, Washington, D. C. on April 26th.

Accomplishments of the conference will be published as they are made known.

Testing Concrete for Absorption

In Which the Shortcomings of Present Methods of Testing Cast Stone Are Discussed and a New Method Is Recommended

By **FRED WEIGEL**
Southern Cement Products Co., Knoxville, Tennessee

SINCE the use of concrete and concrete products in the building industry is increasing widely the question of absorption or more particularly permeability is becoming of vital importance. Permeability being the controlling factor with respect to the resistance of a material to the effects of fire, freezing, long periods of exposure to water and general weathering conditions, it is imperative that a test for absorption or permeability should be indicative of the resistance of this material to the conditions mentioned.

In connection with the manufacture of concrete trimstone it has been necessary for the writer to make numerous physical tests and study the reports of tests made by various commercial laboratories. A summary of several reports from commercial laboratories shows the following approximate results:

	Lb. per sq. in.
Compression, average conditions	6000 to 7000
Compression after freezing in cold room	4000 to 4500
Compression after steaming	3800 to 4000
Absorption per cent of dry weight	7 to 8 per cent
Compression after absorption tests	4000 to 4500
Compression after fire test (heated at 700 deg. C.)	1500 to 2000

After studying the results of these tests the question arises as to the veracity of the exceptionally high figure for absorption as compared with the strength after freezing of 4000 to 4500 lb. per sq. in. or after the fire test of 1500 to 2000 lb. per sq. in. It seems highly improbable that a material carrying as much as 8 per cent by weight of free moisture could show a compressive strength of 4500 lb. per sq. in. after having been frozen at a temperature below 0 deg. F., or a strength of 2000 lb. per sq. in. after being heated to a temperature of 700 deg. C.

As a possible solution to this question it is suggested that some of the hydration products of the cement are being broken down during the continued heating and that some of the combined water as well as the free moisture that is held in the pores of the concrete is being driven from the cement paste. In this connection we quote F. R. McMillan of the Portland Cement Association: "It is the general thought at the present time that the hydration products of cement are both crystalline and amorphous materials, the amorphous material greatly predominating during the early stages with a growth of crystalline material taking place with increasing age of the concrete. It is probable that at no time do the hydration products become entirely crystalline and that the hydrated cement will always contain a sufficient quantity of the 'gel' to cause the cement paste as a whole to exhibit the properties of a colloidal gel. This gel is capable of assuming a variable water content which is fixed by the conditions of temperature and water vapor pressure of the atmosphere in which it is exposed. Under conditions of high temperature the gel tends to lose water; under conditions of low temperature or of high humidity, it tends to take on water." The tests described in the following paragraphs seem to bear out these conclusions quite closely.

Samples were taken from blocks of concrete stone which had been stacked in the yard and exposed to the weather for about one year. The samples were soaked in water at room temperature until they showed no more gain in weight. This required from 72 to 96 hr. Upon breaking the specimens water was found to have penetrated to a depth of less than ½ in. and the centers of the specimens were from all appearances perfectly dry. Pieces chipped off could be beaten into a perfectly dry powder, and gave no indication of containing an appreciable amount of free moisture. The gain in weight during this period of soaking was in most cases from 1 to 1½ per cent and in no case did it exceed 2 per cent. However, these same specimens when placed in an electric oven and dried to a constant weight at a temperature of from 110 to 120 deg. C. showed a loss in weight of from 8 to 10 per cent.

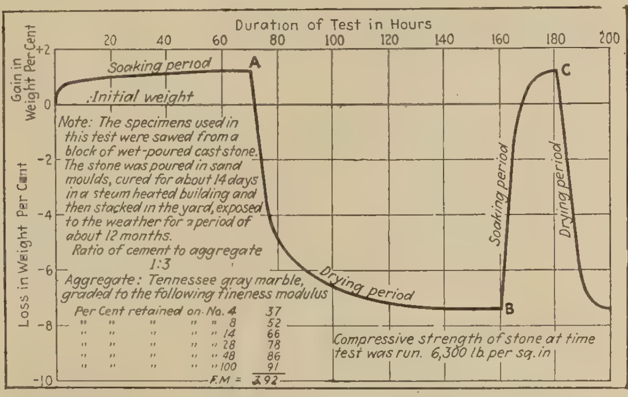


Fig. 1—Variation in weight of concrete alternately soaked in water at 70 deg. F. and dried in an electric oven at 110 to 130 deg. C.

To illustrate this point a curve was plotted (Fig. 1) showing the rate of change in weight of specimens of the stone mentioned above during alternate periods of soaking and drying. During the first period of soaking, 72 hr. was required to bring the specimens to a constant weight. At the point "A" on the curve, the specimens were placed in the oven at a temperature of from 110 to 130 deg. C. and allowed to remain until they showed no more loss in weight. This required about 70 hr. After the curve passes the point "B," there is considerable indication that the physical properties of the concrete have been changed. The second period of soaking required only 20 hr. and the second period of drying was shortened in proportion. It is evident that during the first period of drying considerably more heat was required to reduce the specimens to the dry weight than in the second drying period. This gives us sufficient reason to believe that during the first drying period the mere evaporation of water was not the only action taking place. Likewise, the rapid absorption of water during the second soaking period would indicate that the voids left by the breaking down of the

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products of hydration during the first drying period were being filled with water.

Assuming the conclusions in the foregoing paragraphs to be correct, it would naturally follow that for varying proportions of cement to aggregate we would have a variable loss in weight due to heating. More specifically if all or a part of the water which has gone into combination with the cement is being driven out, the loss in weight when heated would vary directly with the amount of cement contained in the mix, all other factors remaining constant.

Following up this assumption the curve in Fig. 2 was plotted, using the loss in weight while drying at 110 to 130 deg. C. for the vertical ordinates and the ratio of cement to aggregate for the horizontal ordinates. Five sets of specimens were made for this test, using the following ratios of cement to aggregate: 1:0 (neat cement), 1:1, 1:2, 1:3 and 1:4. The specimens were poured in tin moulds and allowed to set for 4 days, when they were removed and placed in damp sand and cured for a period of 28 days. At this time they were soaked in water at 70 deg. F. for 72 hours and then dried to a constant weight in the oven at 110 to 130 deg. C. The loss in weight varied from 35 per cent of the dry weight for the neat cement to 10 per cent of the 1:4 mix. It will be noted that the slope of the curve diminishes as the ratio of the cement to aggregate decreases. This is explained by the fact that gain in weight during the soaking period increases as the ratio of cement to aggregate decreases, which is to be expected. It is quite probable that if the curve had been extended to a ratio of cement to aggregate of 1:8 or 1:10 giving a very poor concrete, the absorption of water during the soaking period would have been great enough to entirely offset the decreasing loss in weight due to the low cement to aggregate ratio and the curve would assume an upward direction.

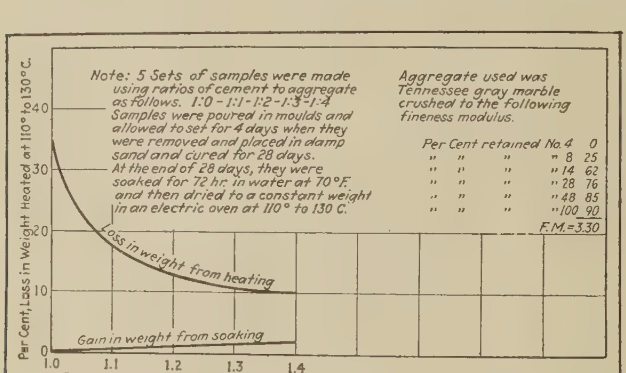


Fig. 2—Effect of heating at moderate temperatures on concrete having variable ratios of cement to aggregate

It might be interesting to note that all of the specimens used in the test just described retained an amount of water equal to 12½ per cent of the weight of the cement, which could not be driven out after continued heating at a temperature of 140 to 150 deg. C. This is consistent with Mr. McMillan's statement that the hydration products of cement are both crystalline and amorphous materials. The crystalline materials having a fixed water content while the amorphous materials are capable of assuming a variable water content which is fixed by the conditions of temperature and humidity of the atmosphere.

The specimens used in plotting curve No. 2 after having been thoroughly dried out were stacked on a shelf in a dry room, and their weights checked regularly over a period of four months. The cubes of neat cement increased about 15 per cent by weight of the cement in this time and the other mixes in proportion. This indicates that the hydration products broken down during the drying period were gradually taking on moisture from the air and that the concrete was assuming its original internal structure. The specimens at the end of the drying period had a white chalky calcined appearance, but at the end of the 4-months period of observation, they had taken on the hard glazy crystalline appearance, common to well-cured concrete; this crystalline structure extended to a depth of ¼ to ½ in. This was particularly noticeable in the cubes of neat cement. Shrinkage cracks and numerous hair lines had almost disappeared.

A new permeability test is the test for absorption recommended by the Bureau of Standard involving the drying of the specimens to a constant weight at a temperature exceeding 110 deg. C. and a subsequent boiling in water for a period of 5 hr. The absorption is the difference between the dry weight and the weight after boiling expressed in per cent of the dry weight. In view of the findings already discussed we believe that this test is of value only when testing concretes having the same ratio of cement to aggregate.

In searching for a method of testing for permeability which would be more indicative of the resistance of the material to weathering conditions the device shown in Fig. 3 was developed. It consists of a ¾ in. to 3 in. pipe bushing bolted between two ¼ in. plates. A hole of a diameter equal to the inside diameter of the bushing is bored in the bottom plate and the test specimen 1 in. thick and 4 in. square, properly protected with rubber gaskets, is slipped between the bushing and the bottom plate. The face next to the bushing must be flat and smooth and the specimen must be fairly uniform in thickness. However, a slight variation may be taken care of if a good heavy gasket is used over the bottom plate. If the face next to the bushing is a troweled surface the thin layer of pure cement which is worked to the surface during troweling should be rubbed off with a carborundum brick. The bushing is then clamped down tightly against the specimen by means of the wing nuts at the top and water under 80 lb. pressure is admitted through the ¾ in. nipple. If leakage occurs between the bushing and the test specimen it may be eliminated by coating the gasket with red lead. The rate of penetration may be expressed as the time required for moisture to show on the outside of the 1 in.

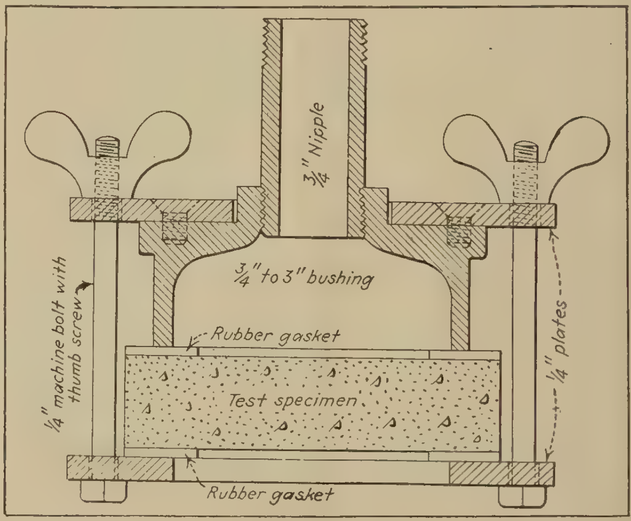


Fig. 3—Device for testing concrete stone, brick, tile and other materials for permeability

slab, or the specimen may be removed and broken after one or two hours and the rate expressed in factions of an inch per hour. The latter method is probably more satisfactory owing to the fact that in some cases the penetration is so slow that even after a certain amount of moisture is finding its way through the slab the evaporation may be rapid enough to keep the outside surface comparatively dry.

A comparison between the relative value of the method of testing commonly used and the test just described may be seen in the following table giving results on two parallel tests on specimens of a natural limestone and a wet poured concrete stone:

	Natural Stone	Concrete Stone
Compression	4100 lb. per sq. in.	6500 lb. per sq. in.
Absorption as indicated by prescribed method	5.5 per cent	7.1 per cent
Freezing with sodium sulphate—spalded	25 per cent	1 per cent
Compression after heating to 700 deg. C.	disintegrated	1650 lb. per sq. in.
Penetration under 80 lb. water pressure	water spewed through 1-in. slab in one minute	⅛ in. per hour

No tests were made for steaming or freezing in cold room.

It may readily be seen that the figures shown for absorption give no indication whatever of the resistance of the materials to the conditions imposed in the remaining tests, while the figures for penetration are directly in keeping with the results obtained in the freezing and fire tests. However, if the specimens of concrete tested for freezing had been thoroughly dried out at 120 deg. C. they would have been badly spalded, bearing out the conclusion that continued heating at this temperature breaks down the internal structure of the concrete, leaving voids into which water rapidly penetrates. Water at 80 lb. pressure went through a specimen 1 in. thick which had been dried at 120 deg. C. in 1½ hr., while it normally requires about 8 hr. to penetrate to a 1 in. specimen in its natural condition. The compressive strength was reduced about 40 per cent by heating for 72 hr. at 120 deg. C.

If the moisture present in concrete in colloidal form is not transient during normal weathering conditions its presence with regard to impermeability, compressive strength, and resistance to freezing and fire should not be objectionable. Careful observation, over a period of four months, of specimens exposed to the weather showed only slight changes in weight. The loss in weight over a long period of hot dry weather was hardly enough to be detected. In most cases the weight of the specimens at the end of the period of observation showed a slight gain over the initial weight.

We realize that the device used in these experiments in testing for penetration is not likely to prove practical as a method of testing concrete in general. It is probably too severe a test for the average concrete placed in construction jobs and very few of the concrete masonry units now on the market would pass it. Also there are a great many cast stone manufacturers who tamp the mix into rigid moulds in a dry or semi-dry condition. Owing to the fact that it is almost impossible to tamp the material in the moulds hard enough to close all the voids, a porous stone results. In order to hold the absorption down in a stone of this character, a waterproofing which reduces the capillarity of the pores in the stone is resorted to. Stone treated in this manner sheds water very well but offers practically no resistance to water under pressure. However, this device served admirably in demonstrating the questions brought up in this paper and that is the purpose for which it was primarily intended.

New Books

Testing Congress Proceedings

Proceedings of the International Congress for Testing Materials. Published by Martinus Nijhoff, The Hague, Holland. The proceedings, which occupy two volumes, include numerous discussions on cement and concrete. Subjects as follows are covered: tests for strength of cement, tests for soundness and setting time of cement, elasticity of cement, shrinking and action of sea water on cement, and highway materials.

Among these discussions are two of particular interest, namely "Design of Concrete Mixtures" by R. W. Crum, and "Volumetric Changes in Portland Cement Mortars and Concrete Due to Changes Other Than Variations in Temperature," by Raymond R. Davis.

These proceedings are a record of the meeting held at Amsterdam, September 12th to 17th, 1927. The next meeting of the organization will be held in 1931.

On Extensometer

An Extensometer and Compressometer of the Hydro-Static Type. Engineering Bulletin No. 25, Engineering Experiment Station of the State College of Washington, Pullman, Washington.

As may be gained from its title, this publication, while but a leaflet of twenty pages, illustrates the hydrostatically operated instrument which was designed and constructed in the laboratory and shops of the college. The three-fold advantages of the instrument, it states, are that it compensates accurately for bending action of the specimen within the gauge length, it can be readily changed to different magnifying powers, and it is flexible and easily and quickly set up where many similar specimens are to be tested.

Three photographs illustrate the text.

"Sand and Gravel in 1927"

The Bureau of Mines of the Department of Commerce has just issued "Sand and Gravel in 1927," a 16-page publication, under the appellation of Estelle R. Phillips. The sand and gravel, it is stated, sold or used by producers in the United States in 1927 amounted to 197,454,269 short tons, an increase of 8 per cent in quantity and 4 per cent in value, as compared with 1926. This exceeds in both quantity and value that reported for any previous year.

These and other facts are found under the heading of production. Other chapter headings include those on values, size of sand and gravel producing companies, glass sand, molding sand, imports, and exports.

A. S. T. M. Index

The American Society for Testing Materials has completed the publication of an index to all A. S. T. M. Standards and Tentative Standards. This is a complete index, supplementing the individual indexes appearing in the society's Books of Standards. It is designed to aid in ascertaining whether the society has prepared a specification or test covering a given material, and giving its title and serial designation and where published in its latest form. The contents occupy 95 pages.

It is planned to issue this publication annually.

From the Products Associations' Bulletins

Northwest Concrete Products Association

F. R. ZAUGG, Secretary

A concrete pipe tonnage report appearing in the April issue of "The Pre-Cast Product" shows a total of 36,000 tons for Washington, and 29,000 tons for Oregon. These figures include 18 and 11 plants, respectively, and are for plain sewer, reinforced sewer, drain tile, plain culvert, reinforced culvert and irrigation pipe.

Other members informed on the subject are asked to correspond with H. A. Hall, of the Eugene Concrete Pipe Company, Eugene, Oregon, whose letter regarding data on concrete chimney blocks appears in the bulletin. The data are being gathered for presentation to the building code committee, insurance people and others interested, and what is desired are insurance rates in various places, letters speaking well of chimney block, from city officials, as well as information on which cities are using the block.

New specifications for concrete culvert pipe for the State of Washington are now reported to be completed and awaiting final approval from the U. S. Bureau of Public Roads.

This issue of the bulletin closes with an item regarding the resignation of F. R. Zaugg, association secretary, to whom much of the credit for the organization's activity is due.

Wisconsin Concrete Products Association

JACK FRANKLIN, Secretary

Within the last month there have been issued by the Wisconsin group two circular letters accompanied by reprints of articles on subjects very pertinent to the merchandising of concrete products at the present time. The first of these concerned "Fool Selling That Kills Profits," warning of the danger of concessions granted mass buyers and as a consequence the manufacturers creating competition for their own distributors.

The second was a reprint of an article by O. H. Cheney, of the American Exchange Irving Trust Company and "profitless prosperity" prediction fame.

The Wisconsin Concrete Products Digest continues to be published and to contain pertinent paragraphs of interest. One of these is entitled "Two Kinds of Co-Operation." The essence of item is that there are two kinds of co-operation in business, viz., geographically, with those who do business in the same community, and industrially, i. e., with those who do business of the same kind. Both types are necessary, it is stated.

The item continues:

John Smith makes concrete block in Ourtown. Around him in the same town are other men making and selling their goods and offering their services. There may or may not be a chamber of commerce in Ourtown and Mr. Smith may or may not be a member, but whether or not there is a chamber of commerce, and whether or not Mr. Smith is a member, he and the grocer and the banker and the other manufacturers have certain objectives in common—objectives which might be summed up as a desire to make Ourtown a better place to do business.

"Many objectives can only be obtained or can best be obtained by organization—by a union of business under a common leadership for a common purpose. And the John Smiths who stay out of the organization in the belief that they can do better by 'Going it alone' or because the organization 'Isn't doing a good job' are shortsighted, for the organization can only function effectively when the John Smiths get in and make it."

On another page is cited an instance typical of many block plants, that of simply filling orders and then forgetting about them. In one case, the Digest states, the local plant supplied a building taking 60,000 blocks in the basement. In another instance, a local plant supplied two buildings using over 60,000 blocks in each building, with several more in view, and in both cases the manufacturer made no attempt to use those facts to his advantage.

"Use your local papers to advantage. Let the community know of the work you are doing, especially when your product is shown to have sufficient merit to be used in large jobs," readers are advised.

Iowa Concrete Products Association

R. L. GAVIN, Secretary

The initial subject of the Iowa association's "Concrete Products News" for April concerns the official disapproval of the construction of a factory building which had been sold for concrete masonry on the grounds that the building was in the fire zone and concrete block could not qualify for structures in that area.

It is then suggested that when other concrete products manufacturers have experiences such as that that they use the copy of the Underwriter's report, soon to be mailed to members' plants, in book form, to refute the claims of the opponents.

Increased membership in the Honor Roll, now limited to two plants, is invited.

The subject of developments in the products industry occupies chief place in the March issue of the bulletin and the six points mentioned are first, that concrete building units are firmly established in the building industry and are being accepted everywhere as dependable materials; second, concrete building units require selling and aggressive manufacturers have adopted careful merchandising plans that will put the products in the wall; third, low-priced units are here to stay; fourth, light-weight aggregates are entering the field in formidable array, presenting an angle that should be studied from every angle by alert products men; fifth, national advertising for concrete products is an assured fact, and sixth, organized effort is now more essential than ever and the industry seems at last to have grasped the importance of having a live functioning products association.

Reinforced Concrete Design Simplified

Chart L—Maximum Unit Compression in T-Beams

By PROF. JAMES R. GRIFFITH
Armour Institute of Technology; Assoc. M., A. S. C. E.

Joint Committee Specifications

$f'_c = 2{,}000$ lbs. per sq. in.
$f_c = 800$ lbs. per sq. in.
$f_s = 18{,}000$ lbs. per sq. in.
$n = 15$

$$f_c = \frac{2M}{(d - t/2)\,bt}$$

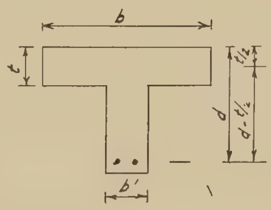


CHART L is a four variable nomograph. The usual procedure in the use of the chart is to draw the first isopleth between the two scales marked (*A*). The intersection of this first isopleth and the support is one point on the second isopleth which must be drawn between the two scales marked (*B*).

In the last issue of CONCRETE a T-beam was partially designed for the conditions:

Total load = 1500 lbs. per lin. ft.
Simple span = 20 ft.
Maximum $\begin{cases} f_c = 800 \text{ lbs. per sq. in.} \\ f_s = 18{,}000 \text{ lbs. per sq. in.} \end{cases}$

Fig. 1-L shows the T-beam thus far designed.

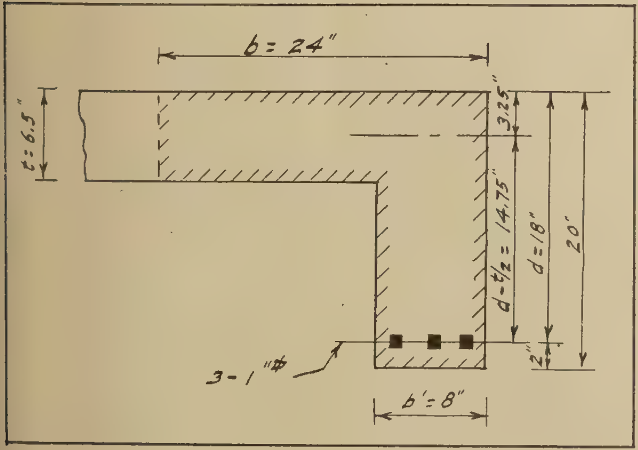


Figure 1-L

In the analytical check solution the unit stress in the steel was found to be 17,850 lbs. per sq. in. for the maximum bending moment of 900,000 in. lbs.

Application of Chart L

From the above information the following data are available for a solution on Chart L.

Given $\begin{cases} (d - t/2) = 14.75 \text{ in.} \\ \text{Flange Area } (bt) = 24 \times 6.5 = 156 \text{ sq. in.} \\ \text{Bending Moment} = 900{,}000 \text{ in. lbs.} \end{cases}$

Isopleth (1), Chart L, is drawn connecting the first two values. Isopleth (2) is then drawn through the third value and the intersection of isopleth (1) with the support. Isopleth (2) then gives a value of

$$f_c = 800 \text{ lbs. per sq. in.}$$

Approximations of Chart L

In the last issue the approximation was made that the center of compression was in the center of the flange area. This made the arm of the resisting couple equal to $(d - t/2)$. In solving for the maximum fiber stress in the concrete, this same approximate arm is used for the resisting couple. One more approximation will be made: That the maximum compression is twice the average stress in compression. This would be true for the case in which the neutral axis came at the lower edge of the flange. In Fig. 2-L the total compression will be seen to be

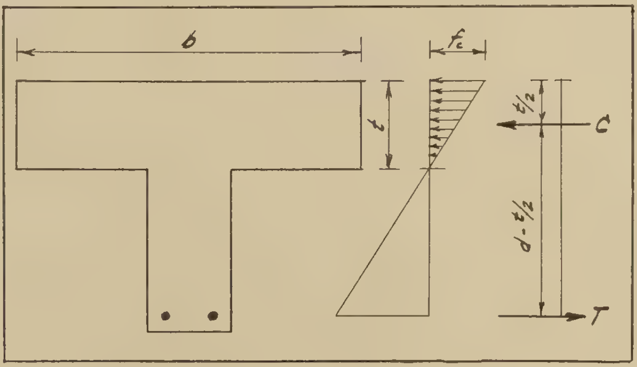


Figure 2-L

$$C = \frac{f_c\,b\,t}{2}$$

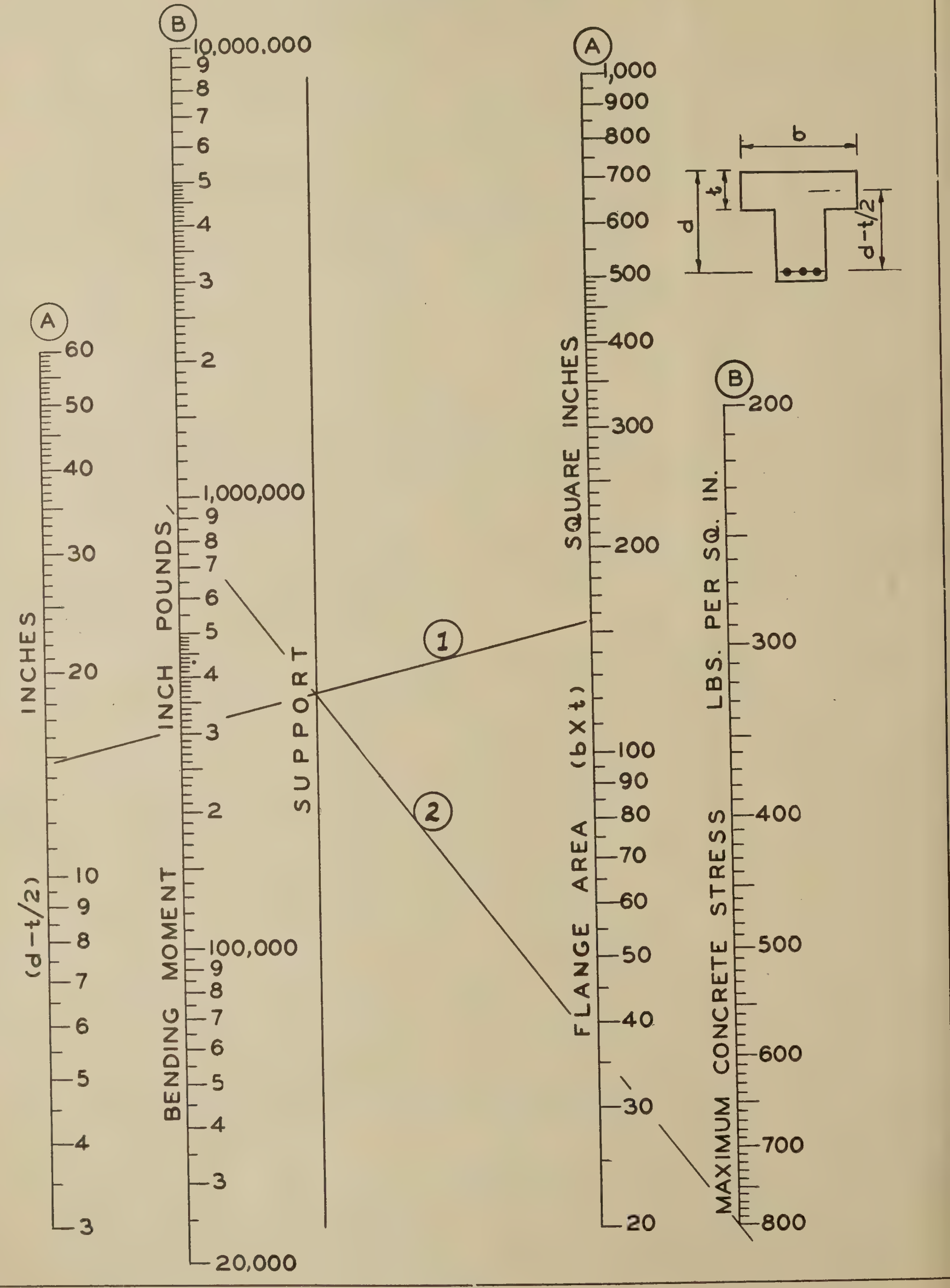
The resisting moment is then

$$M = C\,(d - t/2) = \frac{f_c}{2}\,bt(d - t/2)$$

The maximum compressive stress is then

CHART L

Maximum unit compression
T-Beams



$$f_c = \frac{2M}{bt(d - t/2)} \qquad \text{Eq. 1-L}$$

The quantity (bt) in this equation is the flange area. Chart L has been designed to solve Eq. 1-L.

Analytical Solution

In the last issue the various equations were given for solving T-beam problems. In checking the unit stress in the tensile steel of the given example the approximate formula was used in which the compression in the stem was neglected. The following factors were obtained:

$kd = 6.55$ in.
$jd = 16.8$ in.
$f_s = 17{,}850$ lbs. per sq. in.
$M = 900{,}000$ in. lbs.

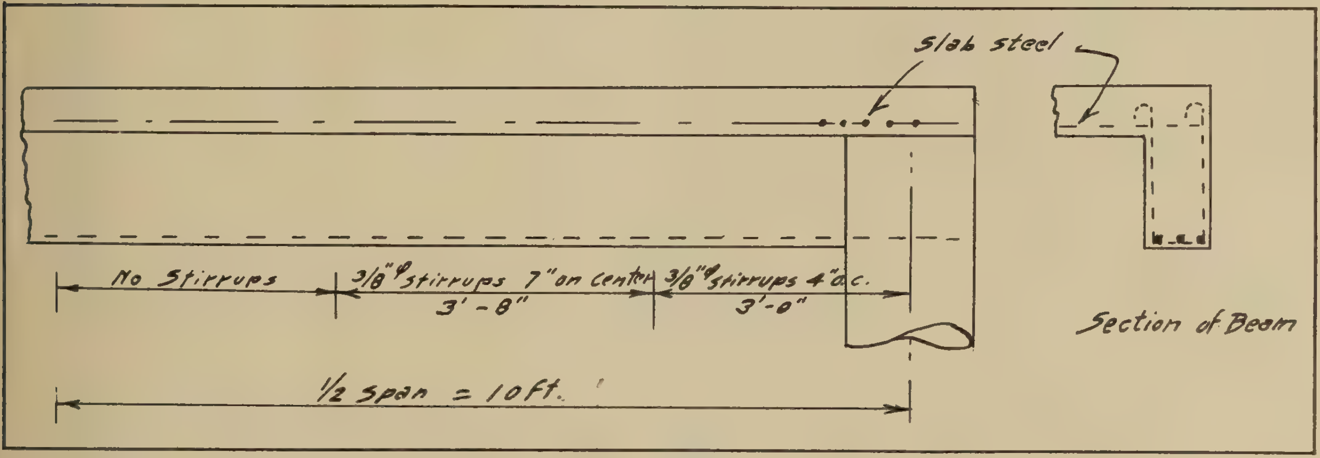


Figure 3-L

Using the corresponding formula giving the maximum compressive stress:

$$f_c = \frac{M\,kd}{bt(kd - t/2)\,jd} = \frac{900{,}000 \times 6.55}{(24 \times 6.5)\ (6.55 - 6.5/2)\ 16.8}$$

$$f_c = 683 \text{ lbs. per sq. in.}$$

This value of (f_c) will be seen to be less than that found by Chart L. This discrepancy is due to the approximations made for the location of the center of compression, and the relation between the average and maximum compressive stress. These approximations being on the safe side, Chart L will always give slightly excessive stresses. The compressive stress is seldom the controlling factor in T-beam design so a rough check is usually sufficient.

Web Reinforcing

The factor in T-beam design exerting more influence than anything else is the shear. The Joint Committee Specifications state "The shearing stress shall be computed . . . . on the minimum thickness of the web of T-beams."

Under Chart D-1 the unit shear in beams was found by the expression

$$v = \frac{V}{bjd} \qquad \text{Eq. 1-D}$$

In T-beams this expression becomes

$$v = \frac{V}{b'jd} \qquad \text{Eq. 2-L}$$

v = Unit shearing stress, lbs. per sq. in.
V = Total shear at section, pounds.
jd = Arm of the resisting couple, taken as $\frac{7}{8}d$.
b' = Width of web, or stem, inches.

The total shear at the end of the T-beam used as an example will be

$$V = \frac{1500 \times 20}{2} = 15{,}000 \text{ lbs.}$$

Going to Chart D-1, for the unit shear, but using (b') instead of (b)

$$\text{Given} \begin{cases} b' = 8 \text{ in.} \\ d = 18 \text{ in.} \\ V = 15{,}000 \text{ lbs.} \end{cases}$$

Obtain $v = 119$ lbs. per sq. in.

This value requires the use of web reinforcing.

From Chart E:

$$\text{Given} \begin{cases} \text{Span} = 20 \text{ ft.} \\ v = 119 \text{ lbs. per sq. in.} \end{cases}$$

Obtain web reinforcing required, $X = 6.7$ ft. from end of the beam.

From Chart F:

$$\text{Given} \begin{cases} \text{Breadth } (b') = 8 \text{ in.} \\ \text{Unit end shear} = 119 \text{ lbs. per sq. in.} \\ \text{Shear 3 ft. from end} = \\ \quad 119\left(\frac{10 - 3}{10}\right) = 82.5 \text{ lbs. per sq. in.} \\ \text{Use } \tfrac{3}{8}\text{-in. round U-stirrups.} \end{cases}$$

$$\text{Obtain} \begin{cases} \text{Stirrup spacing at end} = 4 \text{ in. on center.} \\ \text{Stirrup spacing 3 ft. out} = 7 \text{ in. on center.} \end{cases}$$

Investigating the longitudinal steel for bond we have from Chart D-2:

$$\text{Given} \begin{cases} \text{Three 1-in. square bars.} \\ \text{Effective depth of beam } (d) = 18 \text{ in.} \\ \text{Total shear at end of beam} = 15{,}000 \text{ lbs.} \end{cases}$$

Obtain Unit bond $(u) = 78$ lbs. per sq. in.

Since 80 lbs. per sq. in. is allowable for plain bars, the combination used is satisfactory. Fig. 3-L shows the complete reinforcing details for half the span.

Pans

In joist floor systems metal pans are sometimes used to form T-beams. Since the size of the stem is governed by the unit shear, the end pans are usually made so as to provide for an increase in the stem section near the end of the beam where the shear increases. In the interior of the span where the shear is light, the stem width can be less.

Tile

When tile is used to form the T-beams in the so-called "beam-and-tile" construction, Fig. 4-L, the Joint Committee specifies that:

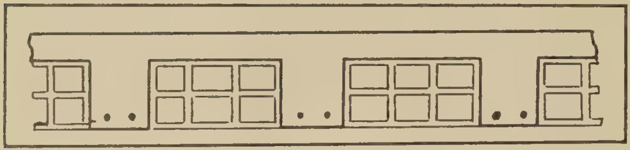


Figure 4-L

"The width of effective section for shear as governing diagonal tension shall be assumed as the thickness of the concrete web plus one-half the thickness of the vertical webs of the concrete or clay tile in contact with the beam."

Chart Construction

As previously mentioned, Chart L has been designed to solve the expression

$$f_c = \frac{2M}{bt(d - t/2)} \qquad \text{Eq. 1-L}$$

Considering the product (bt) as being equal to the area of the flange and that it is one variable, Eq. 1-L can be transposed to the form

$$(\text{Flange Area})\ (d - t/2) = \frac{2M}{f_c}$$

If the arm of the resisting couple $(d - t/2)$ is considered as one variable, the expression is then in the form of a four variable equation. Equating each side of the expression to a common variable (y)

$$y = (d - t/2)\ (\text{Flange Area}) \qquad (1)$$

$$y = \frac{2M}{f_c} \qquad (2)$$

I then have two three variable equations with a common variable (y). Both expressions corresponding to the general expression for nomographic construction

$$C = L^{mn/r} \cdot R^{m(1-n)} \qquad \text{Eq. 7}$$

requiring logarithmic co-ordinates.

In expression (1)

$$y = (d - t/2)\ (\text{Flange Area})$$

the A-10 scale was assumed for values of $(d - t/2)$ and (Flange Area), making the ratio $(r = 1)$. Equating the general exponents of Eq. 7 to the actual exponents of expression (1) and substituting the value $(r = 1)$

$$\left.\begin{array}{l} \dfrac{mn}{r} = mn = 1 \\ m(1 - n) = 1 \end{array}\right\}$$

When solved simultaneously, these two expressions give the values

$$\left.\begin{array}{l} n = \tfrac{1}{2} \\ m = 2 \end{array}\right\}$$

Thus the central scale, containing values of (y) will come half way between the two outside scales, and have co-ordinates one-half the size of those used for the right (R) scale necessitating the A-5 scale. Fig. 5-L shows the scales and spacing for expression (1).

In plotting expression (2)

$$y = \frac{2M}{f_c}$$

the first consideration is to have the central scale for values of (y) plotted to the same co-ordinates as used for expression (1). In order to obtain satisfactory limits and spacing of scales, the D-10 scale was assumed for values of $(1/f_c)$, making the ratio $(m = 4)$:

$$m = \frac{\text{size of } (R) \text{ co-ordinates}}{\text{size of } (L) \text{ co-ordinates}} = 4$$

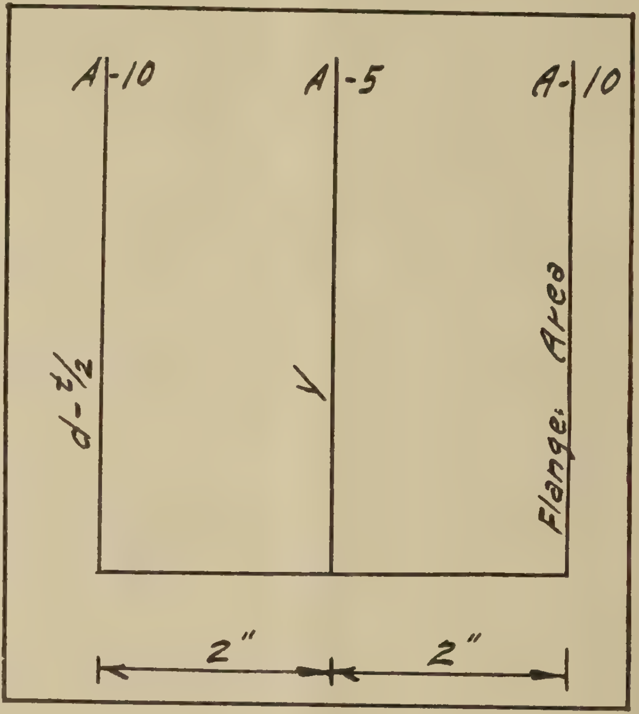


Figure 5-L

Equating the general exponents of Eq. 7 to the actual exponents of expression (2), and substituting the above value of $(m = 4)$, I have

$$\frac{mn}{r} = \frac{4n}{r} = 1$$

$$m(1 - n) = 4(1 - n) = 1$$

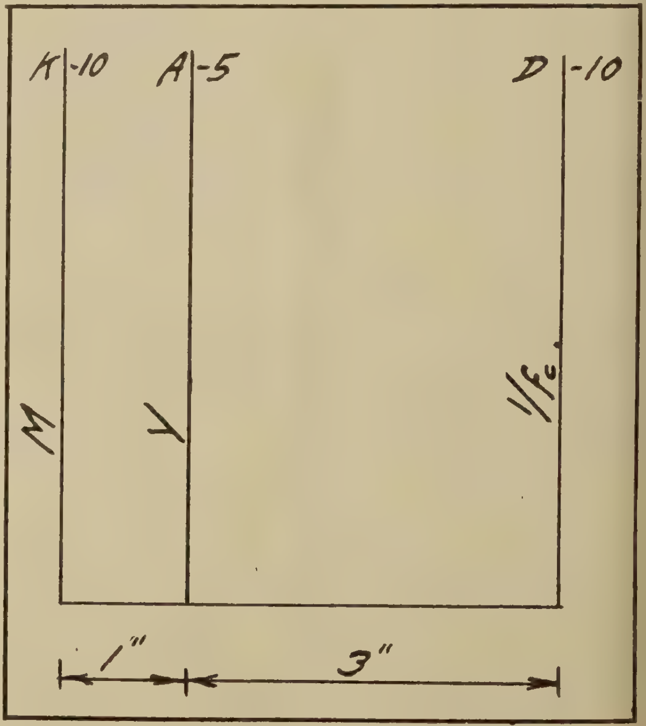


Figure 6-L

When these two expressions are solved simultaneously, the following values are obtained:

$$\left.\begin{aligned} n &= 3/4 \\ r &= 3 \end{aligned}\right\}$$

Thus the central scale will be three-fourths the distance from (R) to (L) and have co-ordinates one-third the size of those used for (R). Fig. 6-L shows the scales and spacing for expression (2). Since $(1/f_c)$ is to be plotted on the (R) scale, these values will progress down the page in reverse order to the other scales.

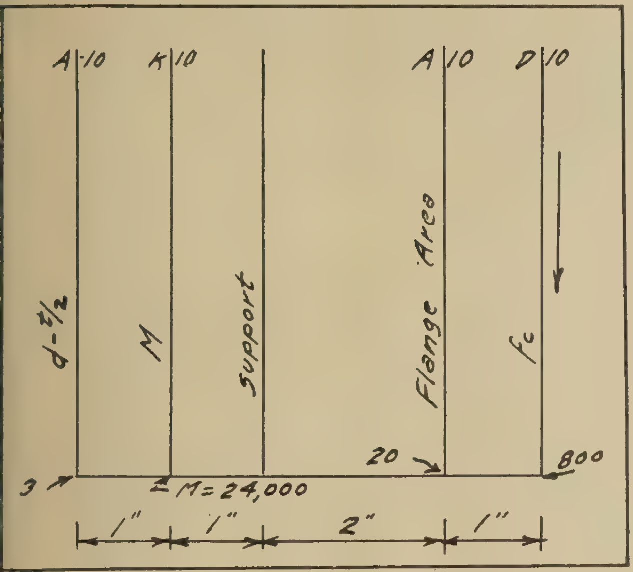


Figure 7-L

Now superimposing Fig. 6-L on Fig. 5-L with the (y) scales in common, the co-ordinates of the (y) scale may be omitted and this line used as a support. The complete details by which Chart L was constructed are shown in Fig. 7-L.

A discussion of an editorial published in a recent issue under the title:

A High Early Strength Specification

Editor CONCRETE:

I have noted with much interest your editorial in a recent issue on "A High Early Strength Specification." At the conclusion of this article you invite discussion. As an engineer connected with a portland cement manufacturer producing a high early strength portland cement, I thus take issue with you on some of the implications contained in your editorial, e. g., that we are led to believe that, with high early strength produced through rich portland cement mixes, we are reasonably certain of satisfactory results. There is considerable doubt as to whether these results are so assured, for in many cases with the rich mixes serious expansion-and-contraction troubles have developed, and increased checking or shrinkage of the concrete has been observed where excessive amount of cement is used. When the ultimate strength is reached with the rich mix, a strength far greater than necessary is attained, and the resulting concrete is more brittle and shatters to a greater degree than when less cement is used. These more or less serious undesirable features in portland cement concrete, made from a mix sufficiently rich to give the early strength desired, should be taken into consideration when contemplating their use.

Cement Improvements

In regard to the alleged uncertainty of results with the present day quick-hardening cement, that is of the same nature chemically as portland cement, the charge of uncertainty of long time results can no more be laid to this so-called "special" cement than to the present day higher quality portland cement. No one questions the stability of the present day portland cement, yet that which is produced by the more modern cement mills of today is as far ahead of the portland cement produced ten years ago, in speed of hardening, as quick hardening cement is ahead of the ordinary portland cement of today. The advance in quality of the quick-hardening cement of today, that possesses the same chemical elements as ordinary portland cement,—as some of them do,—has been produced by a continuation and refinement of the same processes that improved the present day portland cement over the portland cement of ten years ago. If you will investigate the quick-hardening cements, that are of the same chemical nature as the ordinary portland cement of today, you will find the improvement in the quick hardening cement has been brought about chiefly by more careful and thorough treatment of the same materials from which the ordinary portland cement is made, and their improved qualities are largely the result thereof. Better burning practice and finer grinding of the clinker made a greater amount of the ground clinker available as a cement, thus putting it in a form whereby the hardening processes going on, in the resulting quick hardening portland cement, are the same as in the ordinary portland cement, making it just as stable and enduring, and probably more so.

When the foregoing is considered, it may be seen that with quick-hardening cements, produced in the manner described, a rapid-hardening concrete may be obtained without the rich mixes necessary with the ordinary portlands, thus eliminating much of the expansion, contraction, checking, and shrinkage troubles found in rich mixes with ordinary portland cement when they are rich enough to obtain the high early strength in three or four days that may be secured with certain high early strength cements in one day.

I am in thorough agreement with you where you say that specifications should be prepared to apply to the high early strength concrete, and I believe the manufacturers and engineers should get busy and evolve such a specification that will protect the interests of all parties concerned.

(Signed) A. D. CONROW,
Special Engineer,
Ash Grove Lime & Portland Cement Co.

Southwest Road Show

The fourth annual Southwest Road Show and School was held at Wichita, Kansas, from February 26th to March 1st, inclusive. Educational exhibits were presented by the U. S. Bureau of Public Roads, American Road Builders Association and the Republic of Mexico; by the state highway departments of Missouri, Kansas and South Dakota, and by two engineering schools.

Coming Convention

National Fire Protection Association—May 13th to 16th. Thirty-third annual meeting, at Hotel Peabody, Memphis, Tenn.

Painless Bookkeeping For Products Plants

The Seventh Article of a Series on a Simplified Method of Keeping Products Plant Records—Trial Balance—Inventory—Profit and Loss Statement—Balance Sheet—Manufacturing Expense

By F. W. SCHNOEBELEN

Part VII—Closing the Books

The Standard Block Corporation of America, our hypothetical block manufacturing organization whose fortunes we have been following in these pages from month to month, has now been operating for a full month.

We have seen how the books have been opened, what forms have been designed to keep the records, how the records have been entered, etc.

Now, at the end of the first month's operation, we want to know just where we stand. Have we made money or lost? How much did our block actually cost? Is the business in a healthier condition than at the beginning of the month?

How these questions may be answered accurately is the subject of this article.

WHILE it is customary to close the books but once during the year, we will close them at the end of the month to familiarize ourselves with the method. However, before closing the books and preparing the profit and loss statement and balance sheet, it is advisable to prepare working papers, such as Exhibit H. 1, showing the trial balance at the end of the period, adjustment entries, and manufacturing account.

The Working Papers

Exhibit H. 1 shows the trial balance of the Standard Block Corporation in the first two columns at the left of the sheet. As explained in a previous article, we are merely listing the debit and credit balances of the accounts in the general ledger. If the total debits are equal to the total credits, then our books are in balance. In the same two columns as the trial balance, but at the lower end, we make the necessary adjustments. In our books of original entry, we made most of our adjustment, such as accrued expenses and income, depreciation and bad debt reserves, but on the working papers or Exhibit D. 1 we must also make adjustments for the inventories at the end of the period. This is done as illustrated, by crediting the manufacturing account columns and debiting the balance sheet columns.

In our manufacturing account columns on Exhibit D. 1 we show the cost of the goods manufactured. You will notice by studying the illustration that we debit the manufacturing account with inventory value of the finished goods and raw materials at the beginning of the period, purchase of all raw materials, factory pay roll and factory expenses and credit the account with discount allowed on purchases and the amount of the inventory at the end of the period, including finished goods and raw materials. The balance of this account then represents the cost of the goods manufactured, which is transferred to the profit and loss columns as illustrated.

The profit and loss columns on the working papers contain debits for the returned sales and allowances, the delivery expense, selling expense, administrative and office expense, discounts allowed on sales and the cost of the goods manufactured. They credit the account with the total amount of the sales. The balance of the account now represents the net profit for the period. The net profit is then transferred to the balance sheet columns. We may either show the net profit here as illustrated in the working papers or as a surplus. The net profits however are never credited to surplus at the end of the month, but generally at the end of the year. The working papers are then ruled as illustrated.

The working papers furnish a bird's-eye view of all phases of operating during the period as well as the financial condition at the end of the period. They provide all the data necessary for the closing entries, and for the profit and loss statement and balance sheet. Since the net profit, carried from the profit and loss columns to the balance sheet columns, must balance these columns, the use of the working papers as a basis for preparing the closing entries and final statement assures the arithmetical correctness of the closing entries and the statements.

Inventory Record

Before we make the adjustment for our inventories, both finished goods and raw materials, we must determine that amount from our perpetual inventory records. If we will recall, in Parts 2 and 3, when we discussed production and sales, we determined the inventory value of the products manufactured and sold for the month. The information that we filed away is now ready for use. Exhibit H. 2 illustrates how the inventory was determined for the period. To determine the amount of finished goods or manufactured stock on hand, we take the amount on hand at the beginning of the month at inventory value, plus the amount that we manufactured (which is taken from our production book—Part 2) less the amount that we sold at inventory value (which is taken from our sales

Standard Block Corporation of America

WORKING PAPERS, JANUARY 31, 1929

GENERAL LEDGER ACCOUNT	Trial Balance		Manufacturing Account		Profit and Loss		Balance Sheet	
Description	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.	Dr.	Cr.
Capital Stock		40000.00						40000.00
Real Estate	11000.00						11000.00	
Factory Building	12000.00						12000.00	
Reserve for Depr. Bldg.		20.00						20.00
Machinery	9700.00						9700.00	
Reserve for Depr. Machinery		150.00						150.00
Truck	2400.00						2400.00	
Reserve for Depr. Truck		40.00						40.00
Auto—Salesmen	600.00						600.00	
Reserve Depr. Auto Sales		10.00						10.00
Office Equipment	480.00						480.00	
Reserve Depr. Office Equipment		4.00						4.00
Finished Goods 1/1/29	4000.00		4000.00					
Cement 1/1/29	250.00		250.00					
Sand and Gravel 1/1/29	125.00		125.00					
Miscellaneous 1/1/29	25.00		25.00					
Accounts Receivable	4565.00						4565.00	
Good Will	5000.00						5000.00	
Bonds Payable		8880.00						8880.00
Prepaid Insurance		25.00						25.00
Accrued Interest		270.00						270.00
Accrued Taxes		40.00						40.00
Reserve for Bad Debts		60.00						60.00
Bank Account	2800.00						2800.00	
Cash Balance—Cash	10.00						10.00	
Accounts Payable		2551.00						2551.00
Sales		6280.00				6280.00		
Returned Sales and Allowances	50.00				50.00			
Purchases—Cement	1260.00		1260.00					
Sand and Gravel	940.00		940.00					
Miscellaneous Material	110.00		110.00					
Direct Labor	900.00		900.00					
Manufacturing Expense	520.00		520.00					
Delivery Expense	600.00				600.00			
Selling Expense	280.00				280.00			
Administrative and Office Expense	740.00				740.00			
Discount on Purchases		125.00		125.00				
Discount on Sales	100.00				100.00			
	58455.00	58455.00						
	Adjustments							
Finished Goods 1/31/29	4775.00						4775.00	
Manufacturing Account		4775.00		4775.00				
Cement 1/31/29	125.00						125.00	
Manufacturing Account		125.00		125.00				
Sand and Gravel 1/31/29	60.00						60.00	
Manufacturing Account		60.00		60.00				
Miscellaneous Material	15.00						15.00	
Manufacturing Account		15.00		15.00				
	4975.00	4975.00						
			8130.00	5100.00				
Cost of Goods Sold to P. & L.				3030.00	3030.00			
			8130.00	8130.00	4800.00	6280.00		
Net Profit for Month					1480.00			1480.00
					6280.00	6280.00	53530.00	53530.00

EXHIBIT H.2

The Standard Block Corporation of America

INVENTORY

For the Month Ending January 31, 1929

Manufactured Stock		
Finished Goods on Hand, January 1, 1929	$4000.00	
Goods Manufactured January, 1929 (Production Inventory Book Page 36)	4488.00	
	8488.00	
Less—Goods Sold January, 1929 (Sales Inventory Book Page 38)	3713.00	
Total		$4775.00
Cement		
On Hand January 31, 1929 (57 Bbls.)		125.00
Gravel and Stone		
On Hand January 31, 1929 (40 Yds)		60.00
Miscellaneous Expense		
On Hand January 31, 1929		15.00
Total		$4975.00

inventory book—Part 3). This gives us the amount of our inventory of finished goods at the end of the period, or on January 31, 1929. The inventory of our raw materials can be kept perpetual, and as it takes very little time, it is advisable to do it that way.

The profit and loss statement is prepared from the working papers as mentioned before. The operating gains, losses, and expenses should be assembled in the profit and loss statement in the following order:

Gross sales
Less returned sales and discounts
Net sales
Less cost of goods sold
Gross profit on sales
Less delivery and selling expenses
Net profit on sales
Less general and administrative expenses.
Net profit for the period.

EXHIBIT H.3b

The Standard Block Corporation of America

Schedule A

Schedule for Manufacturing Expense for the Month Ending January 31, 1929

Indirect Labor		$175.00
Heat, Light and Power		70.00
Machinery and Building Maintenance		30.00
Supplies		10.00
Insurance		25.00
Taxes		40.00
Depreciation:		
Machinery	$150.00	
Buildings	20.00	170.00
Total		$520.00

Schedule B

Schedule for Delivery Expense for the Month Ending January 31, 1929

Pay Roll—Truck Drivers	$125.00
Cartage	325.00
Auto Expenses	110.00
Depreciation—Truck	40.00
Total	$600.00

Schedule C

Schedule for Selling Expense for the Month Ending January 31, 1929

Advertising	$ 25.00
Auto Expense—Salesman Car	15.00
Miscellaneous	5.00
Salary and Commissions—Salesman	225.00
Depreciation—Salesman Car	10.00
Total	$280.00

Schedule D

Schedule of Administrative and Financial Expenses for the Month Ending January 31, 1929

Miscellaneous Expense	$ 56.00
Salaries—Office	100.00
Salaries—Executive	250.00
Depreciation—Office Equipment	4.00
Bad Debts	60.00
Interest—Bank Loan, Bonds, and 6% Preferred Stock	270.00
Total	$740.00

EXHIBIT H.3a

The Standard Block Corporation of America

PROFIT AND LOSS STATEMENT

For the Month Ending January 31, 1929

Gross Sales					$6280.00
Less Returned Sales and Allowances		$ 50.00			
Less Discounts Allowed		100.00			150.00
Net Sales					$6130.00
Less Cost of Goods Sold.					
Inventory Finished Goods, January 1, 1929				$4000.00	
Add Cost of Goods Manufactured:					
Raw Materials					
Inventory January 1, 1929		$ 400.00			
Purchases	$2310.00				
Less Discounts Earned	125.00	$2185.00			
		$2585.00			
Less Inventory January 31, 1929		$ 200.00	$2385.00		
Direct Labor			900.00		
Manufacturing Expense (Schedule A)			520.00	$3805.00	
				$7805.00	
Deduct Inventory of Finished Goods, January 31, 1929				$4775.00	$3030.00
Gross Profit on Sales					$3100.00
Deduct Delivery and Selling Expenses:					
Delivery Expense (Schedule B)				$ 600.00	
Selling Expenses (Schedule C)				280.00	880.00
Net Profit on Sales					$2220.00
Deduct Administrative and General Expenses (Schedule D)					740.00
Net Profit for the Month Ending January 31, 1929					$1480.00

All of the data may be assembled in one statement, but it is best to condense the profit and loss statement and support it by schedules.

Exhibit H. 3 *a* is an illustration of the profit and loss statement. By studying it, we will notice that the expenses are condensed, i. e., just the totals for manufacturing, selling, delivery and general and administrative are shown. On Exhibit H. 3 *b* are the supporting schedules of the above named expenses. We believe that this is the best way to show the balance sheet for it does not make it so unwieldly or cumbersome. Much is to be gained by studying the profit and loss statement monthly.

We are now ready to make the closing journal entries for the month. The following journal entries are made in the general journal and they will adjust and close the books of the Standard Block Corporation at the end of the month.

Finished goods 1/31/29	$4775.00	
Manufacturing account		$4775.00
(To set up inventory at end of period.)		
Raw materials 1/31/29	$ 200.00	
Manufacturing account		$ 200.00
(To set up inventory at end of period.)		
Discount on purchases	$ 125.00	
Manufacturing account		$ 125.00
(To close discount in purchase into manufacturing account.)		
Sales	$ 100.00	
Discount on sales		$ 100.00
(To determine the net sales in the sales account.)		
Sales	$ 50.00	
Rtrnd. sales and allowances		$ 50.00
(To determine the net sales in the sales account.)		
Sales	$6130.00	
Profit and loss account		$6130.00
(To close net sales to profit and loss.)		
Manufacturing account (total debits as in working papers)	$8130.00	
Finished goods 1/1/29		$4000.00
Raw materials 1/1/29		400.00
Cement		1260.00
Sand and gravel		940.00
Miscellaneous material		110.00
Direct labor		900.00
Manufacturing expense		520.00
(To close the manufacturing cost into the manufacturing account.)		
Profit and loss account	$3030.00	
Manufacturing account		$3030.00
(To close the manufacturing account, transferring the cost of goods manufactured to profit and loss.)		

At this point the balance of the profit and loss account will be the gross profit on sales. The account may be ruled up and the balance brought down in the second division of the profit and loss account.

Profit and loss account	$ 600.00	
Delivery expense		$ 600.00
(To close the delivery expense account into the profit and loss account.)		
Profit and loss account	$ 280.00	
Selling expense		$ 280.00
(To close the selling expense into the profit and loss account.)		

At this point the balance of the profit and loss account shows the net profit on sales. The account may be ruled up and the balance brought to the third division of the profit and loss account.

Profit and loss account	$ 740.00	
General and administrative expense		$ 740.00
(To close the general and administrative expense into the profit and loss account.)		

EXHIBIT H.4

The Standard Block Corporation of America

BALANCE SHEET

January 31, 1929

ASSETS

Current Assets				
Cash in Bank		$ 2800.00		
Cash on Hand		10.00	$ 2810.00	
Accounts Receivable		$ 4565.00		
Less Reserve for Bad Debts		60.00	$ 4505.00	
Inventories:				
Finished Goods		$ 4775.00		
Raw Materials		200.00	$ 4975.00	$12290.00
Fixed Assets				
Real Estate			$11000.00	
Buildings		$12000.00		
Less Reserve Depreciation		20.00	$11980.00	
Equipment:				
Factory	$9700.00			
Less Resr. Depr.	150.00	$ 9550.00		
Automobiles	$3000.00			
Less Resr. Depr.	50.00	$ 2950.00		
Office	$ 480.00			
Less Resr. Depr.	4.00	$ 476.00	$12976.00	
Good Will			$ 5000.00	$40956.00
				$53246.00
LIABILITIES				
Current Liabilities				
Accounts Payable			$ 2551.00	
Accrued Accounts Payable:				
Insurance		$ 25.00		
Interest		270.00		
Taxes		40.00	335.00	$ 2886.00
Fixed Liabilities.				
Bonds Payable				$ 8880.00
Capital				
Capital Stock			$40000.00	
Surplus			1480.00	$41480.00
				$53246.00

The balance of the profit and loss account now shows the net profit for the month, or $1480.00. This amount is then closed into the surplus account by the following entry.

Profit and loss	$1480.00	
Surplus		$1480.00

This concludes the closing of the books for the month. We are now ready to make the final balance sheet for the month ending January 31, 1929. Exhibit H. 4 illustrates the balance sheet. You will recall that on the January 1 balance sheet the ratio of the current assets to the liabilities was 2 to 1, while on Exhibit H. 4, the balance sheet for January 31, the ratio of the current assets to the current liabilities is 4 to 1, indicating greater stability of the business at the end of the period than at the beginning. Any banker would readily advance loans on such a showing. There is also an increase in the fixed assets of the corporation, making the business more valuable. The surplus or profits for the month is considered as additional capital that has not been distributed to the stockholders. We advise the use of the form for the balance sheet as shown on Exhibit H. 4 which can be mimeographed and used at will.

(In the next article we will take up the study of the cost sheet and its use.)

Greater Strength Per Dollar

Why Concrete Yielding 3000 and 4000 Lbs. per Sq. In. Is More Economical Than 2000-Lb. Concrete

(Continued from Page 14)

Table 1.—Portland Cement Concrete, 1/2 to 1 in. Slump

(Suitable for plain concrete pavements and plain mass concrete only in situations where flowability is not essential and particularly for aggregate over 2 in. maximum.)

Strength at 28 days in lbs. per sq. in.	SKILLED CONTROL — Maximum Size of Aggregate					ORDINARY CONTROL — Maximum Size of Aggregate				
	¾ in.	1 in.	1½ in.	2 in.	3 in.	¾ in.	1 in.	1½ in.	2 in.	3 in.
TRUE MIX—VOLUME OF DRY RODDED MIXED AGGREGATE PER SACK OF CEMENT										
1500	7.70	8.35	9.20	9.85	10.00	6.65	7.25	7.85	8.50	9.45
2000	6.55	7.15	7.65	8.35	9.15	5.45	5.90	6.45	7.00	7.70
2500	5.45	5.90	6.45	6.95	7.65	4.55	4.90	5.35	5.80	6.35
3000	4.65	4.95	5.40	5.90	6.40	3.75	4.10	4.45	4.85	5.30
3500	3.85	4.20	4.55	4.95	5.40	3.10	3.30	3.65	3.95	4.30
4000	3.15	3.40	3.70	4.15	4.45	2.45	2.65	2.90	3.20	3.45
SACKS OF CEMENT PER CUBIC YARD OF CONCRETE										
1500	3.40	3.10	2.84	2.65	2.60	3.95	3.60	3.35	3.05	2.77
2000	4.02	3.65	3.42	3.10	2.87	4.83	4.45	4.08	3.70	3.40
2500	4.83	4.45	4.08	3.75	3.42	5.65	5.30	4.90	4.55	4.12
3000	5.55	5.25	4.87	4.45	4.10	6.65	6.20	5.80	5.35	4.95
3500	6.50	6.05	5.65	5.25	4.87	7.70	7.35	6.90	6.40	5.95
4000	7.60	7.15	6.75	6.10	5.80	9.30	8.70	8.10	7.50	7.10
COST OF MATERIALS PER CUBIC YARD OF CONCRETE										
1500	6.06	5.92	5.82	5.77	5.66	6.38	6.20	6.06	5.97	5.82
2000	6.48	6.32	6.19	6.03	5.88	6.88	6.68	6.51	6.31	6.12
2500	6.94	6.77	6.59	6.43	6.25	7.43	7.22	7.00	6.80	6.58
3000	7.43	7.25	7.06	6.84	6.66	8.04	7.82	7.59	7.33	7.11
3500	8.00	7.79	7.58	7.35	7.15	8.74	8.49	8.24	7.97	7.73
4000	8.70	8.47	8.22	7.88	7.70	9.62	9.35	9.06	8.68	8.46
—ECONOMY FACTOR— COMPRESSIVE STRENGTH (LBS. PER SQ. IN.) PER DOLLAR COST OF MATERIALS										
1500	248	253	258	260	265	235	242	248	251	258
2000	309	316	323	332	340	291	299	307	317	327
2500	360	369	379	389	400	336	346	357	368	380
3000	404	414	425	439	450	373	384	395	409	422
3500	438	449	462	476	490	400	412	425	439	453
4000	460	478	487	508	519	416	428	442	461	473

Table 2.—Portland Cement Concrete, 3 to 4 in. Slump

(Suitable for concrete pavements and for mass concrete only where flowability is not essential and particularly for aggregate over 1½ in. maximum.)

Strength at 28 days in lbs. per sq. in.	SKILLED CONTROL — Maximum Size of Aggregate					ORDINARY CONTROL — Maximum Size of Aggregate				
	¾ in.	1 in.	1½ in.	2 in.	3 in.	¾ in.	1 in.	1½ in.	2 in.	3 in.
TRUE MIX—VOLUME OF DRY RODDED MIXED AGGREGATE PER SACK OF CEMENT										
1500	6.80	7.45	8.10	8.80	9.65	5.85	6.40	6.90	7.50	8.25
2000	5.65	6.25	6.75	7.35	7.95	4.70	5.15	5.60	6.10	6.65
2500	4.65	5.15	5.55	6.10	6.55	3.90	4.25	4.65	5.00	5.45
3000	3.85	4.25	4.65	5.15	5.55	3.15	3.40	3.75	4.10	4.45
3500	3.25	3.50	3.85	4.20	4.50	2.55	2.75	3.05	3.30	3.55
4000	2.60	2.80	3.10	3.35	3.65	1.95	2.15	2.35	2.60	2.80
SACKS OF CEMENT PER CUBIC YARD OF CONCRETE										
1500	3.85	3.50	3.22	2.95	2.70	4.50	4.10	3.80	3.48	3.15
2000	4.65	4.20	3.90	3.55	3.30	5.50	5.10	4.70	4.30	3.95
2500	5.55	5.10	4.75	4.30	4.02	6.45	6.00	5.55	5.20	4.83
3000	6.50	6.00	5.55	5.10	4.75	7.60	7.15	6.65	6.20	5.80
3500	7.40	7.00	6.50	6.05	5.75	9.00	8.50	7.90	7.35	6.95
4000	8.85	8.35	7.70	7.25	6.90	11.20	10.40	9.70	8.85	8.35

Table 2—(Continued)

COST OF MATERIALS PER CUBIC YARD OF CONCRETE										
1500	6.26	6.10	5.99	5.87	5.75	6.66	6.45	6.29	6.12	5.96
2000	6.78	6.59	6.44	6.28	6.15	7.25	7.01	6.81	6.60	6.43
2500	7.30	7.09	6.91	6.73	6.57	7.86	7.60	7.37	7.14	6.94
3000	7.90	7.67	7.44	7.22	7.04	8.59	8.31	8.03	7.76	7.54
3500	8.53	8.31	8.03	7.78	7.60	9.41	9.14	8.81	8.51	8.29
4000	9.53	9.19	8.83	8.48	8.27	10.67	10.28	9.87	9.47	9.22
—ECONOMY FACTOR— COMPRESSIVE STRENGTH (LBS. PER SQ. IN.) PER DOLLAR COST OF MATERIALS										
1500	240	246	250	256	261	225	233	238	245	252
2000	295	303	311	318	325	276	285	294	303	311
2500	342	353	362	371	381	318	329	339	350	360
3000	380	391	403	316	426	349	361	374	387	398
3500	410	421	436	450	461	372	383	397	411	422
4000	420	435	453	472	484	375	389	405	422	434

Table 3.—Portland Cement Concrete, 6 to 7 in. Slump

(Suitable for reinforced concrete where usual flowability is required and particularly for aggregate 2 in. and over ¾ in. maximum.)

Strength at 28 days in lbs. per sq. in.	SKILLED CONTROL Maximum Size of Aggregate ¾ in.	1 in.	1½ in.	2 in.	3 in.	ORDINARY CONTROL Maximum Size of Aggregate ¾ in.	1 in.	1½ in.	2 in.	3 in.
TRUE MIX—VOLUME OF DRY RODDED MIXED AGGREGATE PER SACK OF CEMENT										
1500	5.70	6.25	6.75	7.30	8.15	4.80	5.20	5.65	6.15	6.70
2000	4.70	5.10	5.50	6.00	6.55	3.75	4.00	4.40	4.80	5.25
2500	3.75	4.05	4.50	4.85	5.30	3.00	3.25	3.55	3.90	4.20
3000	3.10	3.30	3.55	3.90	4.35	2.35	2.55	2.80	3.00	3.25
3500	2.50	2.65	2.85	3.15	3.45	1.80	1.95	2.15	2.30	2.50
4000	1.85	2.00	2.20	2.40	2.60	1.25	1.35	1.50	1.60	1.75
SACKS OF CEMENT PER CUBIC YARD OF CONCRETE										
1500	4.6	4.2	3.9	3.5	3.2	5.4	5.0	4.7	4.3	3.9
2000	5.5	5.1	4.8	4.4	4.0	6.7	6.3	5.8	5.4	5.0
2500	6.7	6.2	5.8	5.4	4.9	7.9	7.4	6.9	6.5	6.1
3000	7.7	7.4	6.9	6.5	5.9	9.6	9.0	8.4	7.9	7.5
3500	9.2	8.7	8.4	7.6	7.1	11.9	11.2	10.4	9.8	9.1
4000	11.7	11.0	10.1	9.5	8.8	15.2	14.6	13.7	13.1	12.2
COST OF MATERIALS PER CUBIC YARD OF CONCRETE										
1500	6.63	6.46	6.33	6.15	5.99	7.07	6.87	6.71	6.52	6.34
2000	7.28	7.09	6.91	6.71	6.51	7.80	7.58	7.37	7.16	6.94
2500	7.94	7.70	7.47	7.27	7.05	8.60	8.33	8.07	7.86	7.61
3000	8.64	8.42	8.14	7.91	7.65	9.56	9.31	9.00	8.76	8.48
3500	9.63	9.29	8.89	8.63	8.32	10.97	10.60	10.17	9.90	9.57
4000	11.00	10.64	10.15	9.83	9.40	13.06	12.67	12.15	11.82	11.37
—ECONOMY FACTOR— COMPRESSIVE STRENGTH (LBS. PER SQ. IN.) PER DOLLAR COST OF MATERIALS										
1500	226	232	237	244	250	212	218	224	230	236
2000	275	282	289	298	307	256	264	271	279	288
2500	315	325	335	344	355	291	300	310	318	329
3000	347	356	369	379	392	314	322	333	342	354
3500	363	377	394	406	421	319	330	344	354	366
4000	364	376	394	407	426	308	316	329	338	352

Table 4.—Portland Cement Concrete, 8 to 10 in. Slump

(Suitable for reinforced and thin sections where the maximum flowability is required and particularly for aggregate under ¾ in. maximum.)

Strength at 28 days in lbs. per sq. in.	SKILLED CONTROL Maximum Size of Aggregate ¾ in.	1 in.	1½ in.	2 in.	3 in.	ORDINARY CONTROL Maximum Size of Aggregate ¾ in.	1 in.	1½ in.	2 in.	3 in.
TRUE MIX—VOLUME OF DRY RODDED MIXED AGGREGATE PER SACK OF CEMENT										
1500	4.35	4.70	5.20	5.65	6.15	3.40	3.75	4.10	4.45	4.85
2000	3.35	3.70	4.00	4.45	4.85	2.60	2.80	3.10	3.40	3.65
2500	2.70	2.85	3.15	3.40	3.76	1.96	2.10	2.30	2.45	2.70
3000	2.10	2.20	2.40	2.60	2.80	1.35	1.45	1.60	1.75	1.87
3500	1.50	1.58	1.67	1.85	2.10	0.85	0.90	1.00	1.10	1.25
4000	1.05	1.10	1.15	1.25	1.35	0.40	0.45	0.53	0.55	0.65

Table 4—(Continued)

SACKS OF CEMENT PER CUBIC YARD OF CONCRETE

1500	5.9	5.5	5.0	4.7	4.3	7.2	6.7	6.2	5.8	5.3
2000	7.3	6.7	6.3	5.8	5.3	8.9	8.4	7.7	7.2	6.8
2500	8.6	8.2	7.6	7.2	6.7	11.2	10.6	9.8	9.3	8.6
3000	10.6	10.2	9.5	8.9	8.4	14.5	13.9	13.0	12.1	11.6
3500	13.6	13.1	12.6	11.7	10.6	18.3	17.9	17.1	16.3	15.2
4000	16.7	16.3	16.0	15.2	14.5	21.8	21.4	20.7	20.7	19.8

COST OF MATERIALS PER CUBIC YARD OF CONCRETE

1500	7.32	7.11	6.88	6.72	6.54	7.89	7.66	7.40	7.22	7.01
2000	8.13	7.86	7.60	7.35	7.14	8.96	8.67	8.38	8.11	7.87
2500	8.97	8.73	8.37	8.15	7.84	10.25	9.99	9.60	9.36	9.02
3000	10.26	10.01	9.59	9.20	8.94	12.14	11.87	11.42	11.01	10.72
3500	11.97	11.72	11.39	10.92	10.33	14.53	14.26	13.90	13.41	12.79
4000	13.63	13.42	13.15	12.93	12.50	16.94	16.71	16.41	16.17	15.71

—ECONOMY FACTOR—

COMPRESSIVE STRENGTH (LBS. PER SQ. IN.) PER DOLLAR COST OF MATERIALS

1500	205	211	218	223	229	190	196	203	208	214
2000	246	255	263	272	280	223	231	239	247	254
2500	279	286	299	307	319	244	250	260	267	277
3000	292	300	313	326	336	247	253	263	272	280
3500	292	299	307	321	339	241	245	252	261	274
4000	293	298	304	309	320	236	239	244	247	255

Ship American Concrete Block Machinery for Building Model Russian Community

On April 8th a shipment of 42 cases of concrete block plant equipment went forward to Russia (Union of Soviet Socialist Republics) from the Detroit plant of the Abram Cement Tool Co. for the purpose of erecting a concrete block plant at St. Kavkazskaia.

The events that led up to this purchase, which is the first of a number of similar purchases, are of interest. About eighteen months ago a group of Russian industrial workers who had been in the United States for several years, organized the "Modern Poultry Community (Blagoeff Ruthenberg)" whose purpose it was to purchase American machinery and equipment to establish a model farming community in Russia.

In October they sent a delegate to Moscow to investigate conditions and to see the site that had been offered to the association by the Soviet Socialist Republic for the purpose of establishing a modern poulty farm community.

Upon the return of this delegate, final plans were made. It was decided to build modern concrete block homes and farm structures and to develop the project along the lines of successful American practice.

For this purpose the machinery was purchased and additional machinery and equipment will go forward later. The Abram Cement Tool Co. also had booklets printed in the Russian language, setting forth present-day methods of concrete block manufacture and containing detailed instructions for securing quality concrete block.

Peter V. Kratchoff is the organizer and chairman of the Board of the Blagoeff-Ruthenberg Commune.

Bureau Continues Absorption Tests of Cast Stone

In tests it has made the Bureau of Standards has determined the absorption of numerous samples of cast stone. In connection with this work it has been suggested that the absorption may be due to a low dry weight of the sample caused by partial dehydration of some of the colloidal material present in the stone when the latter is dried at temperatures as high as 110 deg. C. It is also possible that high absorptions may result from boiling the sample for the total absorption, thus producing continued hydration of some of the cement which has not set.

With these possibilities in mind, the following method of absorption was tried. Cores were cut from each of 12 typical samples. These were maintained at 35 deg. C. in dry air until a loss of not more than 0.05 per cent in four hours was obtained. The specimens were then totally immersed in 300 deg. mineral seal oil and the absorption noted over a period of 48 hours. Then the specimens and oil were placed in a closed chamber, the pressure reduced and maintained at 4 mm. mercury for five hours. The absorptions were then calculated to the equivalent of water as per cent of dry weight of specimens. The specimens absorbed from 1.6 to 9.3 per cent in 48 hours, one specimen being below 2 per cent. After reducing the pressure to 4 mm. the absorptions ranged from 2.2 to 13.4 per cent.

Thus, even under conditions where the possibility of dehydration is reduced and the rehydration eliminated, cast stone does absorb a considerable quantity of water and the absorption as generally carried out, using water, is a fair measure of the pore space of the stone.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit, Michigan.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth St., New York City.

American Road Builders' Association; Miss E. A. Birchland, Secretary, 29 W. Thirty-ninth St., New York City.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 W. Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer, Secretary, 1150 Munsey Bldg., Washington, D. C.

Cast Stone Institute; Frank M. Brooks, Secretary, Pasadena, Calif.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Concrete Products Association; F. O. Matthiessen, Secretary, 644 Drexel Building, Philadelphia, Pa.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Iowa Concrete Products Association; R. L. Gavin, Secretary-Treasurer, 1002 Hubbell Bldg., Des Moines, Iowa.

National Association of Builders' Exchanges; Earl F. Stokes, Secretary, 15 E. Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.
Thirty-third annual meeting, May 13th to 16th, Hotel Peabody, Memphis, Tenn.

The National Lime Association, Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N.W., Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Building, Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Building, Cleveland, Ohio.

Northwest Concrete Products Association; F. R. Zaugg, Executive Secretary, 803 Seaboard Building, Seattle, Wash.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 W. Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Building, 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 3115 Plankinton Arcade, Milwaukee, Wisconsin.

25 YEARS AGO

IT is difficult to realize that there was a time when there were decided differences of opinion on the question of "wet vs. dry concrete." Yet, in the May, 1904, issue of CONCRETE—just 25 years ago—there is an article by James W. Sussex, summarizing the data then available on this persistent subject. It was published under the title, "The Relative Strength of Wet and Dry Concrete."

In his introduction, Mr. Sussex bemoans the fact that so little information on this subject is available. He says that he has been able to find only two records of experiments on wet and dry concrete.

One of these sets forth a description of an experiment made by Irving Hitz of the C. M. & St. P. Ry. This "experiment consisted of two cubes, each containing about a yard of concrete, which were split open by wedges when one month old." Why this was done and how it shed light on the subject, is not explained. At any rate, Mr. Hitz' conclusions were: "1. A moderate excess of water is not injurious. 2. More labor is necessary in mixing and placing a dry or moderately dry mixture than a wet one. 3. It is impossible to get a compact concrete without using what is theoretically an excess of water."

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The second experiment referred to was made by H. W. Parkhurst, of the Illinois Central Railroad. He made three cubes of wet, dry and medium mixtures and split them open by wedges at the age of one month. The conclusion was that the medium concrete was the strongest.

—‡—

The author of this article then describes his own experiments, made to extend the range of knowledge on this subject. These were much more elaborate and consisted of 45 6-in. cubes made with three percentages of water and broken in a testing machine at the ages of 7 days, one month and three months.

Mr. Sussex concluded from his experiments that: 1—There is no condition of age or amount of tamping which shows dry concrete to be the strongest. 2—Dry concrete should never be used under any circumstances. 3—Medium concrete may be used where immediate strength is required. 4—Wet concrete is stronger than either dry or medium, at any age over three months.

How opinion has changed!

—‡—

In speaking about the "Outlook for New Cement Plants," an article calls attention to the fact that New York state has undertaken to spend over $100,000,000 in the improvement of the Erie Canal and says, "We shall be fortunate if American cement works will be able to supply the demand (for the cement required) without allowing large contracts to escape us and go to foreign producers."

—‡—

"There is some question yet as to the best method of putting up portland cement for the market," says an article in this issue. It discusses the use of barrels and cloth sacks and reprints a letter from a Houston dealer who advocates the use of paper sacks.

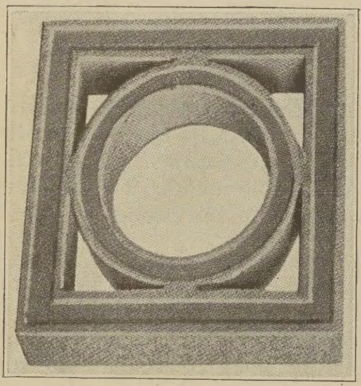
At this time, also, a uniform weight of 95 lbs. for cement in sacks and 380 lbs. for cement in barrels was agreed upon by the cement manufacturers.

New Equipment and Materials

Safety Flue Block Produced on Multiplex Machine

A flue block new in design and fully meeting requirements of building codes, according to the manufacturer, may be produced on a machine now being marketed. The block is of one-piece construction with no joints exposed to heat or outside air, which at the same time causes it to serve as an insulator and non-conductor of heat. This fact, together with that of it being possible to produce a half flue to be used for the discharge of gas, eliminating a hazard present wherever the half flue is not used, is an appreciable feature.

In addition, the block is light in weight, the outside wall having twenty cores. Positive lugs center the flue liners in laying up. It may be laid up singly or in a battery of flues and over roofs of any design.



The Multiplex Concrete Machinery Company, Elmore, Ohio, manufactures the flue block machine.

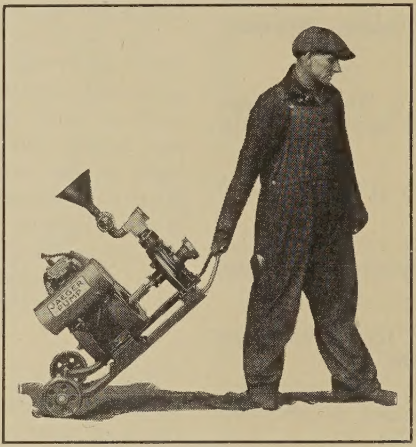
New Butler Weighing Hopper with All-Steel Scale

The Butler Bin Company of Waukesha, Wis., announce a new and improved type of weighing hopper equipped with a Butler all-steel scale.

Some of the outstanding features of this hopper are that it ships as a complete unit with scale attached and can very easily be installed on any steel, wood or cement bin by merely bolting the frame to which the hopper is suspended over the openings in the bin. There are three radial gates, two for stone and one for sand. A tell-tale dial indicates overweight and underweight. Counter balanced automatic discharge gates allow the weighed batch to discharge into the truck or mixer. Platform or ground operation may be provided for. Where specifications require the weighing hopper can be equipped with separate full capacity beam and poise for each material to be weighed.

Jaeger "Speed Boy" Pump One of Multitude of Firm's New Products

Extensive additions to the factory of the *Jaeger Machine Company*, at Columbus, Ohio, have now completed what is said to be the largest concrete mixer plant in the world, standing near the site where the first small Jaeger tilter was constructed in a one-room machine shop 21 years ago.



Already makers of one of America's largest line of concrete mixing equipment, the increased facilities permit a monthly output of many hundreds of outfits—trailers, tilters, non-tilting mixers and plaster-mortar mixers. In addition, it accommodates important new lines of pumps, towers, placing and handling equipment which the Jaeger company has acquired and designed and is already producing on a large scale.

With its 1929 line of spring mounted mixers, the company has announced a complete series of diaphragm, lift and centrifugal pumps, in all sizes. The Speed Boy, an 8,000 gallon, non-clogging centrifugal outfit, so portable that it may be wheeled about by one man and easily carried between two boys, is a special feature of the line.

New Drainage Pump Operated by Outboard Motor

A new type drainage pump which is powered with a Johnson outboard motor and is self-priming and will shut itself off whenever there is no water to be pumped, is now being manufactured by the Johnson Motor Company.

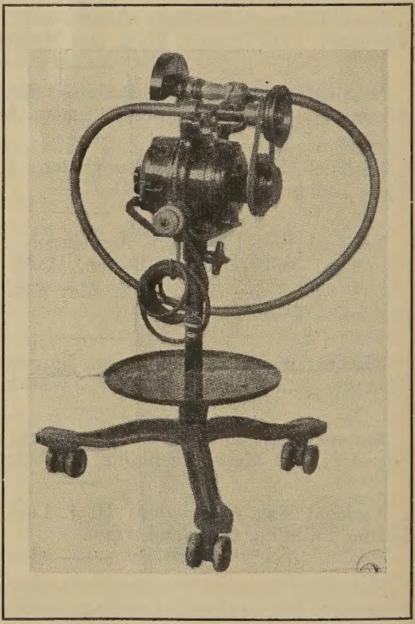
The pump consists of a long pump shaft with a light twin cylinder outboard motor mounted on the top. This motor powers the impeller which is located at the bottom of the shaft. As the pump shaft sinks to the bottom of the water and the impeller is always submerged no air can be sucked while there is still water to be pumped. An ingenious safety device short circuits the magneto of the motor when water is not passing through the pump.

It uses include pumping water from excavations, concrete forms, man-holes, and barges. It is also found highly useful in dredging work of all kinds.

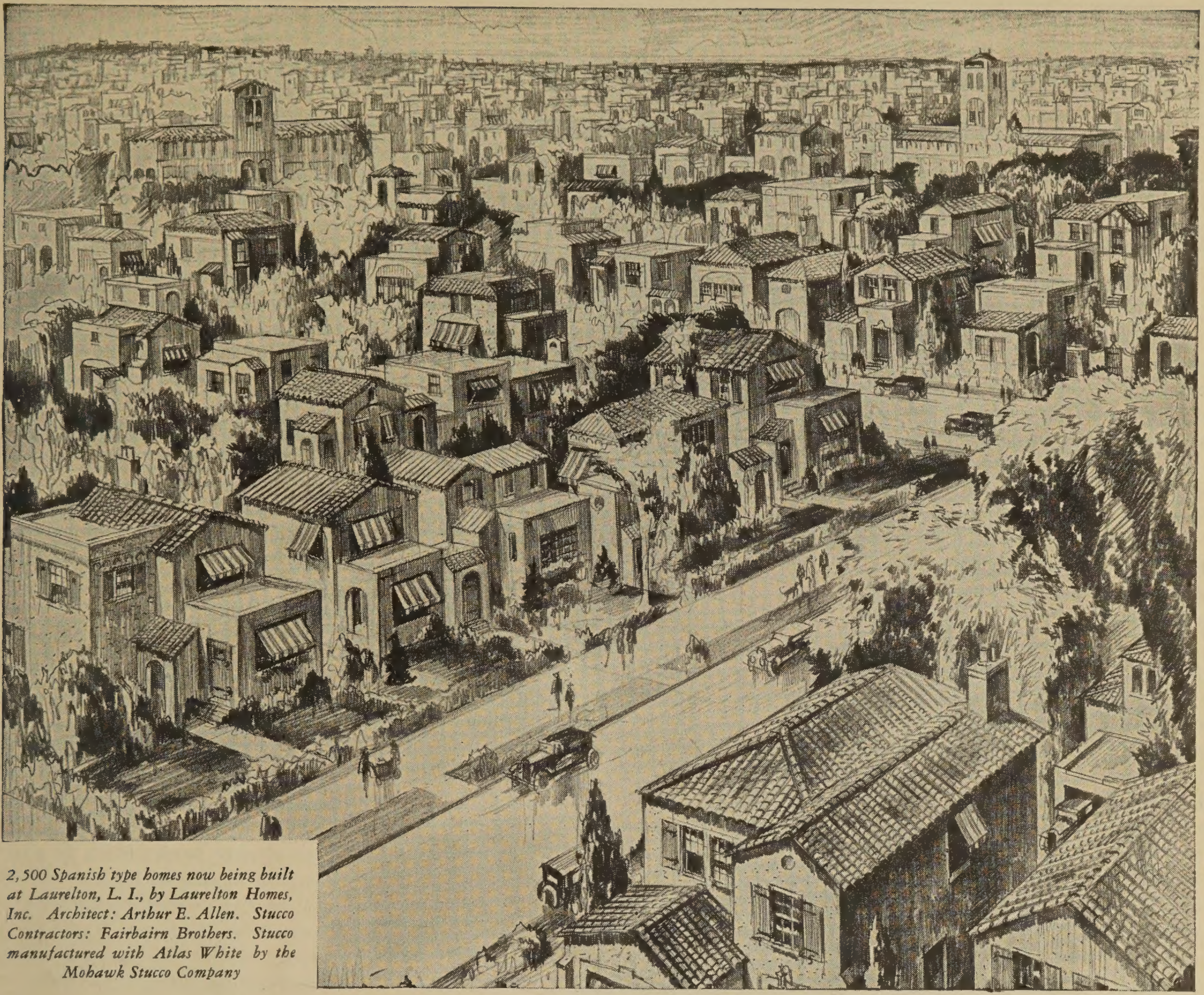
Cast Stone Finishing Equipment

For cast stone finishing operations manufacturers have found useful the Portflex No. 2, similar to the unit shown in the accompanying illustration. This is one of a line of portable power transmission pieces of equipment that are products of the Dallett Company, Philadelphia, Pa.

The unit is designed to give easy, free movability always within range of the work. There is available, according to the manufacturers, a versatility of speeds due to the countershaft arrangement with positive means for making changes without loss of time.



The unit shown includes as standard equipment a portable mounted motor, "V" type endless belt, flexible shaft, ball-bearing hand piece, wheel guard, 12 ft. rubber cable complete with switch and fixtures, two flat wrenches, oil and grease.



2,500 Spanish type homes now being built at Laurelton, L. I., by Laurelton Homes, Inc. Architect: Arthur E. Allen. Stucco Contractors: Fairbairn Brothers. Stucco manufactured with Atlas White by the Mohawk Stucco Company

A town sheathed in ATLAS

"What type of houses will please clients and sell fastest?" The importance of that question was multiplied twenty five hundred times at Laurelton, Long Island. And twenty five hundred times the answer was stucco made with Atlas White Portland Cement.

With what wisdom, is evidenced by the fact that over nine hundred homes already completed have been sold and there is a waiting list of purchasers crowding the builders of this notable project.

In addition to beauty in color and design, the homeseeker of moderate means finds in these houses fire-safeness, economy in upkeep, and permanence. The same qualities will add to the desirability and market value of the houses which you build.

° ° °

You can purchase Atlas White or Atlas Gray Portland Cement in any quantity from your own building material dealer. He is the only distributing agency between the Atlas plants and your concrete job. The flexible service which he offers on Atlas and the direct delivery of cement to the user bring Atlas to you at less expense than by any other method. And because he performs this essential, economic service, the dealer makes a vital contribution to the upbuilding of the community.

ATLAS
PORTLAND CEMENT

THE ATLAS PORTLAND CEMENT COMPANY, MAIN OFFICES: NEW YORK, ST. LOUIS
BOSTON · ALBANY · PHILADELPHIA · CHICAGO · DES MOINES
OMAHA · KANSAS CITY · OKLAHOMA CITY · WACO · BIRMINGHAM

About Makers of Equipment and Materials

Notes from the Field

Pittsburgh Laboratory Executives

The Pittsburgh Testing Laboratory, inspecting engineers and chemists, Pittsburgh, Pa., have just elected *B. H. Witherspoon* as president and *A. R. Ellis* as vice-president in charge of operations.

Mr. Witherspoon was formerly district manager of the Remington Rand Business Service, Inc., in Los Angeles, California.

Mr. Ellis has been affiliated with the Pittsburgh Testing Laboratory since 1910, and has been general manager and director since 1921.

Robbins & Myers Crane Division

A complete new line of improved electric and hand power cranes, hoists and trolleys up to 10 ton capacity is announced by *Robbins & Myers, Inc.,* pioneer manufacturers of electric motors, motor-generator sets and electric fans. The executive, technical and sales personnel of the new division were all formerly associated with the Chisholm-Moore Manufacturing Company of Cleveland in similar capacities.

Frank F. Seaman has been appointed general manager. Sales are in charge of *John R. Mears.*

Bates Bar Tie Account

The Hunter Machinery Company, with plants located at Detroit and Grand Rapids, Michigan, now have the exclusive sales rights on *Bates* bar ties and tying tools for the state of Michigan, an announcement states.

"Form-Holds" Merge

Due to growth of business, the *Concrete "Form-Hold" Corporation,* Culver City, Calif., has been merged with the *American "Form-Hold" Corporation* of Delaware.

Stuebing Cowan Grows

The Stuebing Cowan Company, builders of lift and industrial trucks and skids, with general offices in Cincinnati, Ohio, and plants in Cincinnati and Holyoke, Mass., have recently enlarged their Holyoke plant. Capacity will be trebled.

Servicised and Carey Agree

Announcement was made recently that litigation pending between the *Servicised Products Corporation,* Chicago, Illinois, and the *Philip Carey Manufacturing Company,* Lockland, Ohio, was terminated on December 21, 1928.

As of that date, the Servicised Products Corporation was granted and is now manufacturing premoulded products under a license on patents owned by the Philip Carey company, including, in addition to patents formerly owned by that company, all patents heretofore owned by the Servicised Laboratories, Inc., relating to premolded products, such as expansion joint, rail filler, and construction materials.

Other than the above, the two companies are entirely distinct corporations.

Industrial Literature

Material Equipment

Literature descriptive of the Erie combination volume-weighing AggreMeter is now available in the form of a four-page folder enlarging on its various features.

AggreMeter plants, according to the publication, are self-cleaning, and built entirely of steel and designed for large overload.

Other Erie equipment such as electric buckets, overhead traveling cranes, and clamshell buckets are described in a second, similar, publication.

Erie products are manufactured by the *Erie Steel Construction Company,* Erie, Pa.

Centrifugal Pumps Publication

A new publication, issued by *Barrett, Haentjens & Co.,* Hazelton, Pa., describes a method used to make suction lift centrifugal pumps automatic. This bulletin, while dealing with but one automatic pumping system, is of rather general interest.

The subject is treated in a complete though simple manner. It shows how the centrifugal pump can be started and stopped by a float switch, push button, pressure regulator, or time switch. It explains the way in which the pump is primed, and describes the several devices used to protect the pump and electrical equipment against damage due to loss of prime, suction air leaks, a broken discharge pipe, and many other adverse operating conditions.

New Equipment

Use Concrete Surfacer to Meet Highway Specifications

Many highway contractors meeting today's finish specifications of an absolutely uniform machined surface are employing the Berg concrete highway surfacer, known as "A one-man machine." Its manufacturers recommend it for cutting down high spots, surface irregularities, uneven expansion joints and repaired patches. Its features are said to be the eliminating of large working crews, the low operating cost, and its equal effectiveness on new and old roads.

The surfacer is pronounced to be an all-steel machine, requiring no special instructions for operation.

This model machine is also used for surfacing concrete floors of buildings, garages, swimming pools, etc. It is a product of the Concrete Surfacing Machinery Co., Cincinnati, Ohio.

Header Block Equipment

When straight concrete blocks are used as back-up for brick, it is necessary for the contractor to have a special shaped header block for use when occasional header brick courses are to be provided for.

To produce header block an attachment has been introduced for use with the Anchor Type G stripper block machine by the Consolidated Concrete Machinery Corp., Adrian, Mich. The attachment has three advantages, according to the manufacturer: First, it reduces the cost of making header blocks to less than the cost of full blocks because it makes them at exactly the same speed, with the same labor and with less material; second, the header block has clean-cut angles and true edges; and third, the header block has exactly the same texture and strength as a standard block.

A Time-Saving Triple Gate for 3-Compartment Bins

A solution to the problem presented when two sizes of coarse aggregate are used in the making of concrete is offered by the Blaw-Knox Company in the development of a triple gate, all three openings being controlled from one point. This arrangement allows the operator to control the charging and discharging of the weighing batcher from a position directly in front of the reading beam of the scale, upon which the batcher is suspended.

The device consists of an arrangement of three standard trough shaped no-jam gates parallel to each other, operated by means of rack and pinion. An arrangement of sliding gears, actuated by turning an auxiliary shaft, engages each gate pinion separately with the operating crank.